Defining and Measuring "Knowledge Capital" in Health Service

Doctoral thesis submission by
Sumathi Sundram
University of East Anglia
Faculty of Medicine and Health Sciences
& Norwich Business School

28th October 2011

Defining and measuring "knowledge capital" in health service

Abstract

"Knowledge capital" comes in many forms based on the context of its creation, some in terms of pure knowledge, some of which is public good and some rival. Furthermore, some of its forms are less easy to describe since it includes custom, practice and understanding of how best to organise things. Practitioners and academics, across disciplines of organisational management, economics, and accounting define the concept of "knowledge capital" (KC) or "intellectual capital" (IC) as human skills enhanced by organisational structures, resources and relationships to form a composite knowledge based resource, which creates competencies, capability and capacity that generate revenue for the organisation.

Health service provision is based on the transfer of tacit, explicit, established and emerging knowledge. The capture of learning gained during service delivery is therefore critical for the safety, effectiveness and quality of service provision co-creating knowledge based resources including enhanced understanding, skills, processes and routines. The need arises, therefore, to understand if the way resources are managed should change to take account of the generation of more or less of something that is of value to health organisations and systems.

The joint production and "public goods" features of inexhaustibility and non-exclusivity, in certain circumstances, make the measurement of "knowledge capital" in health challenging. The management and maintenance of this key resource in health service

requires it to be recognised and measured, although there are problems in defining "knowledge capital". There are challenges in measuring it and even bigger ones in valuing it. There is a need, therefore, to start with a clearer understanding on what it is and then attempt to measure it.

This research through an empirical case study highlights the co-creation of, explores its nature and attempts to measures the scale of "knowledge capital" in health service, as a resource. The models "knowledge creation cycle in health" and "dimensions of knowledge capital in health" developed from the literature review are investigated in the study of the specialised pulmonary hypertension (PH) services at Papworth hospital, a NHS specialist centre. The additional dimensions of "public goods in health" and "capacity in health" are surfaced in this study.

Management accountancy method of costing, informed by the economic concept of opportunity cost of capital, provides a helpful mechanism for the measurement of this difficult to measure resource in this study. This method is based on the estimates of the inputs of joint production of "knowledge capital" using the "bottom up" approach being recommended by NHS guidance. This case study at Papworth hospital reveals that the scale of the value of stock of "knowledge capital" can be more than twice the value of its tangible assets. This highlights the necessity for management strategies of health organisations and health systems to recognise fully its co-creation and measure the scale of “knowledge capital” in health service. A systematic stock take of "knowledge capital" assets in health organisations and systems is therefore recommended to enable informed decision making for effective and efficient management of health services.

Defining and measuring knowledge capital in health service

Defining and Measuring "Knowledge Capital" in Health Service

Chapter 1 Introduction

Academics from management and economics (Nonaka, 1994; Stewart, 1997; Winter, 1987; Teece, 2000; Foray, 2004) recognise the increased importance of knowledge as a key factor of production. This is because of developments in information and communication technology together with liberalisation and globalisation of markets. The way organisations create, disseminate, retain and use both tacit and explicit knowledge in the course of producing goods and services generates knowledge based resources called "knowledge capital". They (Winter, 1987; Bontis et al., 1999; Teece, 2000; Bontis, 2002a; Marr et al., 2003), further agree that "knowledge capital" is a composite knowledge based resource, which includes both individual and organisational elements.

There is agreement that management of this resource has an impact on performance and growth of organisations (Nonaka, 1994; Hamel and Prahalad, 1996) and economies (Winter, 1987; Teece, 2000; Foray, 2004). Organisations and economies therefore need to account for, manage, plan and optimise production and utilisation of "knowledge capital" generated. The challenges in defining and measuring this resource are recognised (Winter, 1987; Teece, 2000; Bontis, 2002a; Marr et al., 2003; Foray, 2004) as its porous nature makes it difficult to define, control, measure and value. It is necessary, nevertheless, for organisations operating in modern economies to attempt to define and measure knowledge based resources in order to support effective decision making.

Academics (Good, 2001; Clarke and Wilcockson, 2002; Fitzgerald et al., 2005; Nicolini et al., 2008) agree that health service provision requires a spectrum of knowledge as an essential input. Additionally, as Løwendahl et al. (2001) suggest, the generation of knowledge in health happens in tandem with service provision. The outputs of health service therefore have greater value than simply that of the clinical services delivered as measured in purely health outcome terms (Drummond et al., 2005; McPake et al., 2002). Measuring and managing “knowledge capital” in the health context, therefore, may be essential to enable effective and safe delivery of services.

The nature of "knowledge capital" is such that parts of it, in certain circumstances similar to knowledge, could be potentially inexhaustible and accessible to all in society thus making it difficult to measure, control and trade. Additionally, the current financial reporting regulations do not always support the costs of knowledge production to be accounted fully as a separate input of production and as a joint output of goods and service provision. The dilemmas of measurement of this resource, as acknowledged by both accountants (Sveiby, 1997; CIMA, 2001) and economists (Winter, 1987; Teece, 2000; Foray, 2004; OECD, 1999) have meant such assets are not included in the financial reports of organisations (Petty and Guthrie, 2000; Guthrie, 2000).

These dilemmas are also encountered in measuring joint inputs and outputs of health service provision. Joint outputs that derive from knowledge generated in service provision are not yet reported and managed as an integral part of health service provision by NHS organisations. The lack of such reporting in health service organisations can potentially lead to under reporting in the health system of the full spectrum of values generated through the provision of health service. Such under-reporting in turn raises the possibility of under-resourcing of the generation of "knowledge capital" in health service organisations, consequently raising the need for the definition and estimation of the value of this joint output.

Estimations of value based on inputs of joint production, as used by accountants and economists (Drummond et al., 2005; Drury, 2006), potentially provides a feasible start for measuring the difficult to measure resource that is "knowledge capital". The definition and measurement of “knowledge capital” by health service organisations could shed light on the significant long term value generated from development of skills, processes and knowledge to improve services. The capture and use of such knowledge generated in service provision can thereby be developed and managed.

1.1. Focus of this thesis

This thesis explores the generation and nature of “knowledge capital” as a resource in the health context. "Knowledge capital" is an important non-physical resource generated in organisations which helps create value and economic growth for the organisation (Winter, 1987; Nonaka, 1994; Edvinsson and Sullivan, 1996; Stewart, 1997; Sullivan, 1998; OECD, 1998; Teece, 2000; Foray, 2004; Marr, 2005). This composite resources is generated from the experience, learning and use of the knowledge generated in the process of delivering services.

The aim of this thesis is to understand the nature of “knowledge capital” by deriving conceptual models that support its definition and measurement as a resource within health organisations. These models are used in an empirical study as frameworks to understand it as a measureable resource in health service by seeking answers to the following questions.

1. What do key managers understand as the resource inputs for providing health services?
2. How can these resources be allocated between the joint outputs of service provision?
3. How can "knowledge capital" be measured based on data and information used in decision making?
4. How useful are estimates of inputs in providing a basis for developing monetary and non-monetary metrics for the estimation of the difficult to measure outputs that form the "knowledge capital" of the organisation?

The context of its generation is empirically explored through understanding the spectrum and processes of transfer of knowledge in the provision of specialist health service, in order to define and measure this resource in health. A number of perspectives can be used for understanding and measuring "knowledge capital", including historical, clinical management, growth economics, political, psychological, knowledge management and innovation management. The questions addressed in this thesis seek to provide insight, informed by the perspectives of those providing health services, for measuring this resource in order to support a more informed decision and policy making within health service.

The model, "knowledge creation cycle in health", is therefore developed from a management perspective. This is used as a framework within a case study for understanding the processes and resources as used in service provision and measured within the organisation. Informed by accountancy and economics approaches to measurement of joint outputs an estimate of "knowledge capital" is derived. The second model, "dimensions of knowledge capital in health" is used as a framework for attempting to disentangle the component parts of this resource and derive an estimate of the stock of "knowledge capital" within the organisation.

A case study design is chosen to accommodate a range of data, such as interview transcriptions, meeting notes, quantitative reports, accounts and administrative data in the attempt to understand the phenomenon. A mixed method approach is used as both qualitative and quantitative data are required for this study. Furthermore, a management accountancy approach that is familiar to the organisation, informed by an economic production method, enables the identification and measurement of the resources used as inputs for pulmonary hypertension services at sub-speciality service level. An internal management perspective is therefore used to identify the resources utilised for the co-production of specialised health service and components of "knowledge capital".

Estimates of resource use form the basis for allocating and measuring outputs in terms of clinical services and "knowledge capital" generated in health service. Based on analysis of such estimates, the value of “knowledge capital” generated as an output of this service provision is derived, to the extent possible. Further analyses of non-clinical funding generated shed light on the not so visible and difficult to measure outputs that form the stock of "knowledge capital" in health.

Understanding the interdependent and joint production of service and “knowledge capital” in health highlights the challenges in measuring these difficult to measure but significant outputs comprising skills, knowledge and processes necessary for safe health service provision. These challenges for measurement are addressed by using cost of inputs of production when encountered by accountants and economists in measuring joint and not clearly defined or partly traded outputs that yield long term benefits. Management accountancy methods informed by approaches from economics (Drummond et al., 2005; NICE, 2008) could provide a feasible start for the measurement of this hard to measure resource. In the health service the drive for efficiency, as measured by waiting times, bed days, and national reference costs, may lead to some of the intangible outputs of service delivery being omitted. Such omission can be because of the difficulties encountered in the measurement of these outputs that yield benefits over a longer time frame.

1.2. Structure of this thesis

Section I describes the development of two conceptual models to understand and measure "knowledge capital" as a resource in the health context. It consists of chapters 2 to 4, and contains the literature review and analysis exploring the nature of "knowledge capital" and measures used in management, accountancy and economics literature. The analysis enables the derivation of models to support the understanding of the context of health service provision leading to a definition and measurement of "knowledge capital" generated in a health service organisation.

Chapter 2 describes the evolution of the concept of "knowledge capital" in management of organisations through a review of literature from management, accountancy and economics disciplines. The review helps to understand the importance, role and nature of "knowledge capital" in the performance and development of organisations and, in turn, economies. Further, reviews of accountancy and economics literature supported the understanding of how monetary value is attributed to resources that are used in production as estimated in reports used within organisations for decision making and to external stakeholders.

Chapter 3 reviews the literature relates to the role of knowledge in the processes of health service delivery and creation of health knowledge, which transform into knowledge based resources of the organisation. The review supports the understanding of the creation of “knowledge capital” and the challenges for its measurement in the health context.

Chapter 4 synthesises the findings of the literature reviews of chapters 2 and 3 into conceptual models. These models provide a framework to understand the context in which resources are used and to support their allocation between the joint outputs of health service provision. Furthermore, a categorisation model is developed for use in an empirical study to support the disentanglement and measurement of the component parts of “knowledge capital” in health in monetary and non-monetary terms.

Section II describes the empirical study undertaken to highlight the issues and challenges raised in the measurement of "knowledge capital" as a joint output of health service provision. The two models developed in section I serve as frameworks in an attempt to identify and measure “knowledge capital” that is generated by a health service organisation. The empirical study is a case study on the delivery of specialised pulmonary hypertension health services provided by a NHS specialised health service hospital. Within the case study, the model "knowledge creation cycle in health" is used as a framework to understand the context of health service provision. This, together with management accountancy techniques, supports the identification and allocation of resources used in the joint production to the extent feasible. These measurements of the joint inputs of production are further used as the basis for an estimation of "knowledge capital" that is co-created in service provision. Further analyses of these outputs using the model "dimensions of knowledge capital in health" support the categorisation of the component parts of this resource and the derivation of an estimate of the stock of "knowledge capital" in a health organisation.

Chapter 5 explains and describes choice of research design, service and setting of the empirical study together with the organisational and policy background for health service provision in England and Wales. An emerging treatment is selected as the unit of analysis for the processes of new knowledge creation and health service delivery overlap, potentially making some of the knowledge based outputs tradable. The outputs of joint production are thus made more visible in part.

Chapter 6 describes the methods undertaken in the study for understanding the delivery of pulmonary hypertension services at Papworth hospital. The reasons for studying the delivery of pulmonary hypertension services at Papworth hospital are further discussed. The study is undertaken in two phases. In Phase I a management accountancy led “bottom up” costing approach is used to collect data for identifying and costing the resources used and in allocating the revenue received from the NHS for clinical service provision. Phase II supported data collection for the identification and analysis of other sources of funds generated from the non-patient related services. These funds generated and used by the Papworth hospital pulmonary hypertension team over seven years are identified and analysed to categorise the component parts of “knowledge capital”. Such funds are interpreted as returns on investment in activities not directly related to clinical care. Using capital asset pricing principles an estimate of the stock of "knowledge capital" of the team is derived.

Chapter 7 sets out the findings and observations from the Papworth hospital study and the study is critically reviewed and discussed.

In Chapter 8 the implications of the findings from this study are categorised as relevant to policy makers, commissioners and providers of health services. The significant value to the organisation of “knowledge capital” that is generated from the capture, use and dissemination of tacit knowledge in the course of health service provision, as raised by the empirical study, is examined. The implications, for the health system, of recognising the joint and interdependent production of health services and the generation of “knowledge capital” in health are highlighted. Despite the challenges of measurement, the significance of attempting to measure “knowledge capital” in health, using data and information currently available to health organisations, is discussed. The implications of measuring this resource for informing decision making in health service organisations and for policy making within health systems are detailed.

1.3. Conclusion

Health service delivery and knowledge creation are interdependent which needs recognition and management for the safe and effective delivery of health services. The embedding of the knowledge created from service delivery into routines, systems and relationships of the health organisation, forms “knowledge capital” in health. The benefits derived from “knowledge capital” spillover from health organisations into the wider health system and society thus raising challenges for its measurement. Such challenges have meant health organisations and systems do not recognise or measure this resource.

To a certain extent, health service organisations can estimate a disaggregated cost of service delivery and "knowledge capital" by using the management accountant's approach of “bottom up” costing. Through such disaggregation of costs, organisations can make a start in estimations of the cost of resources used for other non-clinical outputs of health service provision. Organisations, in identifying and measuring “knowledge capital” in health, could start to recognise, measure, and account for some of the long term benefits that spillover into wider health systems and the wider economy. An estimate of the stock of "knowledge capital" suggests that it may be of greater value than that of the tangible assets managed by hospitals.

Health service organisations and systems need to consider and attempt to measure the key output of "knowledge capital", using data and information currently used in managing health organisations, despite the above discussed difficulties of measurement. In health, this is a resource created by the wider spectrum of value generated by skills development, service capacity development, new knowledge generation, patient information and education all in the course of service provision, alongside health outcomes. The study findings recommend a start on the systematic collection and audit of the "knowledge capital" assets at hospital and health system level.

Section I Conceptual model development

Section I consists of chapters 2 to 4. Chapter 2 and 3 describe the methodology used to review literature on "knowledge capital" and the implications for definition and measurement of "knowledge capital" in health. Chapter 4 synthesises findings from the literature review developing models for understanding and measuring the resource in the health context through an empirical study.

The aim of this thesis is to understand and develop definitions and methods to measure “knowledge capital” in health that is generated in an organisation during the provision of health services. “Knowledge capital” is seen as a resource generated in organisations through the daily processes of producing goods and services and its value determined by the context of its use (Edvinsson and Sullivan, 1996; Stewart, 1997; Winter, 1987; Teece, 2000). This thesis, therefore, draws mainly on literature relating to management of organisations, economics and management accounting to understand the concept of “knowledge capital” in the health context. The concept is explored through the internal strategic and operational perspectives of a health service organisation, to find feasible mechanisms to define, measure, and manage "knowledge capital" as a resource in health service.

Chapter 2 The phenomena of "knowledge capital"

2.1. **Introduction**

This chapter explores the concept and measurement of “knowledge capital” as it has evolved within organisational theory, accountancy and economic disciplinary perspectives. The aim of this chapter is to understand and describe the place and structure of “knowledge capital” as a measurable concept in the management of organisations and its impact on the wider economy. Building on the understanding gained from this chapter, the next chapter explores this concept in the health service context.

The concept of “knowledge capital” emerged because of developments in communication and information technology, which brought to the fore the need for organisations to manage knowledge based resources. A number of disciplines such as economics, organisational management, accountancy, knowledge management and technology, have explored linked concepts in this field in order to understand knowledge based resources as a key factor of production. A variety of descriptions for these concepts has been suggested. There is no definitive definition of "knowledge capital" at present. Academics and practitioners nevertheless converge in perceiving this concept as a cluster of resources generated within an organisation through the sharing of knowledge in the daily business of producing goods and services and generate value for the organisation (Winter, 1987; Edvinsson and Sullivan, 1996; Stewart, 1997; Roos et al., 1997; Sveiby, 1997; Teece, 2000). These are knowledge based resources such as routines, processes and systems created within organisations including relationships generated within and external to the organisation. Such resources in creating additional value help organisations to be competitive in the changed business environment. Understanding the context of an organisation's core business is therefore essential in attempting to measure “knowledge capital” as a resource of an organisation.

Organisations are seen as a stock of tangible, intangible and financial resources in the “resource-based” theory (Bontis, 2002b). Nonaka (1994) shifted organisational management thinking from such a view to one of viewing organisations as institutions that create, both “tacit” and “explicit”, knowledge and processes that generate such knowledge in the course of their business activities. Echoing economists, a number of organisational theory academics (Senge, 1990; Nonaka, 1994; Nevis et al., 1998) raised the significance of enhancing and capturing the learning generated in the course of routine business. The emergence of the knowledge based economy shifted organisations’ management focus from “tangibles” to “intangibles”, as suggested by Edvinsson & Sullivan (1996) and Stewart (1997). This shift in management focus, Foray (2004) argues, resulted in organisations producing more services than goods.

Economists such as Winter (1987), Teece (2000) and Foray (2004), recognise knowledge generated largely within a firm as a key factor of production in the knowledge economy and its significance for economic growth and innovation. Foray (2004) in analysing knowledge as an economic resource highlights the challenges posed in measuring knowledge resources, which exhibit the features of “public goods” such as lack of excludability and lack of rivalry exhibited by knowledge in certain circumstances. Teece (2000) further elucidates the differences in the nature of the challenges posed in managing knowledge based resources, exhibiting “public goods” features, to that of tangible resources.

Similarly, accountants preparing reports under financial accounting guidelines are struggling to include information on intangible “knowledge capital” (OECD, 1996; Roos et al., 1997, Sveiby, 1997; Guthrie, 2000; Marr, 2005) as these joint knowledge based outputs are not fully identifiable or robustly measureable. They measure resources used and outputs generated in organisations to support decision making and report externally to stakeholders and regulators. Statutory reports are produced in terms of actual financial outflows using guidelines based on principles of prudence in order to reflect the true and fair view of the financial state of the organisation. As Drury (2006) however highlights, management accountancy principles are used in measuring resources within an organisation to support budgeting, cost and benefit analysis in service planning and capital investment appraisals. These reports in an organisation aid decision-making for planning and control therefore dynamic in nature accommodating other non-financial and qualitative data. Management accountancy methods therefore may well provide organisations with a platform for attempting to measure "knowledge capital" a resource where the context of its creation and use provides its value.

At the macroeconomic level, the external reports produced by organisations provide the base for measurement of economic activity such as gross domestic product (GDP) at the national level. As early as 1997, the Danish Trade and Industry Development Council (DTIDC), later called Danish Agency for Trade and Industry (DATI), recognising the significance of knowledge based resources generated within organisations, started to develop guidelines for organisations to account and report on such resources, namely “intellectual capital”. One aim of the project was to understand the level of investment made by organisations in activities, such as staff training, the development of in house software and so on that created intangible assets. Additionally, the project aimed to develop guidelines to account for and understand the impact of such intangible assets of organisations on the growth of an economy. Building on this initial work, the Organisation for Economic Cooperation and Development (OECD, 1999), began attempts to measure “intangible” resources and estimate their impact on the growth of an economy. A number of studies under the project named “Measuring Intangibles to Understand and Improve Innovation Management” (MERITUM) were launched with European Union funding to develop guidelines for organisations to manage, measure and report on intangible resources.

As a starting point, this thesis uses the definition of “knowledge capital” as the knowledge based assets created by an organisation in using tacit and explicit knowledge in order to deliver its business objectives. Such assets include those generated by the organisation based on its relationship with its suppliers, customers and industry at large. In this thesis, therefore, an organisation’s internal management perspective on how resources are used and managed through routines, systems and relationships for production of goods and services, provides a basis for categorisation and measurement of "knowledge capital" generated in the organisation. The examination of health service provision, a service which exhibits "public goods" characteristics in certain circumstances, is undertaken in chapter 3 to understand the significance of "knowledge capital" in this context.

2.2. **Methods of literature review**

A systematic review of literature involves the search of papers on a topic and selection of studies for inclusion based on relevance and quality of each study. The findings from the selected studies are synthesised in an unbiased way to interpret the findings in a balanced impartial summary. Informed by these principles, this exploratory study uses a systematic approach for the literature review, with a view to understanding the evolution, definition, measurement and management of the concept of “knowledge capital”.,

The search strategy of the review uses the following terms, “knowledge assets”, “knowledge capital”, “intellectual capital”, “intangibles”, “knowledge creation” and “knowledge management” in searching relevant databases. Additionally, the author's prior experience in financial management at the strategic level of health service organisations informed the choice of keywords. The variety of terms used in the search reflects the background disciplines, namely management science, accounting and economics, the perspectives from which the concept is being studied. Furthermore, the knowledge based component of "knowledge capital" as a resource is recognised in the search terms.

The databases searched for the literature review are Science Direct, Emerald, Wiley Interscience and Elton B. Stephen Company (EBSCO) hosted databases, Academic source Elite, Business Source Elite, Medline, CINAHL plus and Econlit. EBSCO hosts the largest full text database for business journal, health related journals and peer reviewed publications, including a wide range of subject areas related to business. Emerald publishes a wide range of business and management journals, which provides access to global thinking on management science. Science Direct and Wiley Interscience are databases that provide access to a wide range of science and scientific management related journals. Medline is the database used within the health service, but searches for this study generated papers on management of particular diseases and none on "knowledge capital".

The initial focus for this search is on literature related to strategy, R&D management, services management, knowledge management, economics, accounting and financial reporting. Such a focus is adopted as the core of the concept is based on knowledge created and captured within organisations in response to changes in the environment in which businesses operate. The source books and papers of relevant references cited in the literature are identified and reviewed. Prior reviews by Petty and Guthrie(2000), Brennan and Connell (2000), Bontis (2002b) and Marr (2005), indicate that the main contributions to the field are published after 1985, therefore the chosen databases are searched for papers published in the English language mainly from 1985 to 2011. Additional review is undertaken to identify key papers and books on the subject from citations in papers identified by the literature search. This is to increase the understanding of the context of the emergence of the concept, and thereby enable a balanced and unbiased synthesis and interpretation of the literature.

A further aspect of the review is to understand and identify the underlying disciplinary concepts that support the evolution of the concept from the economics and accounting perspectives. Literature from IT technical systems development is excluded as these focus on the development and architecture of technical systems based on explicit knowledge generated within organisations. Such technical developments can form part of the "knowledge capital" in organisations. The development of such systems is however not considered in this study, hence such studies are excluded. The focus in this study whereas is on understanding and measuring value of the knowledge based resources generated in health as a result of the transference of tacit knowledge to explicit and vice versa in service provision.

In this thesis, a strategic management approach is taken to answer the questions raised by the concept of "knowledge capital". Literature from a managerial perspective including economics and accountancy literature is chosen as being a meaningful and feasible approach for this study, for the questions addressed in this thesis are primarily managers' questions.

2.3.**Organisational and management perspective**

2.3.1 Emergence of the concept of "knowledge capital"

Knowledge emerged as a key factor of production through the convergence of technological innovations and patterns of communication changing the means and scope of communication between people. Additionally, the liberalisation and globalisation of markets further stimulated the knowledge economy. This increased accessibility raised the importance of knowledge as a tradable commodity and relevance of the term "knowledge based intangibles" (Guthrie and Petty, 1999). Drucker, as early as 1993, used "intellectual capital" to describe post capitalist society, suggesting that traditional factors of production such as land, labour and capital had become secondary to knowledge. The terms "intellectual capital", "knowledge capital", "knowledge organisations", "learning organisations", "organisational learning", "information age", "knowledge era", "intangible assets", "information assets", "intangibles management", "human capital", and "hidden values" are all used in the literature to describe forms of economic assets created in which knowledge is a key factor of production.

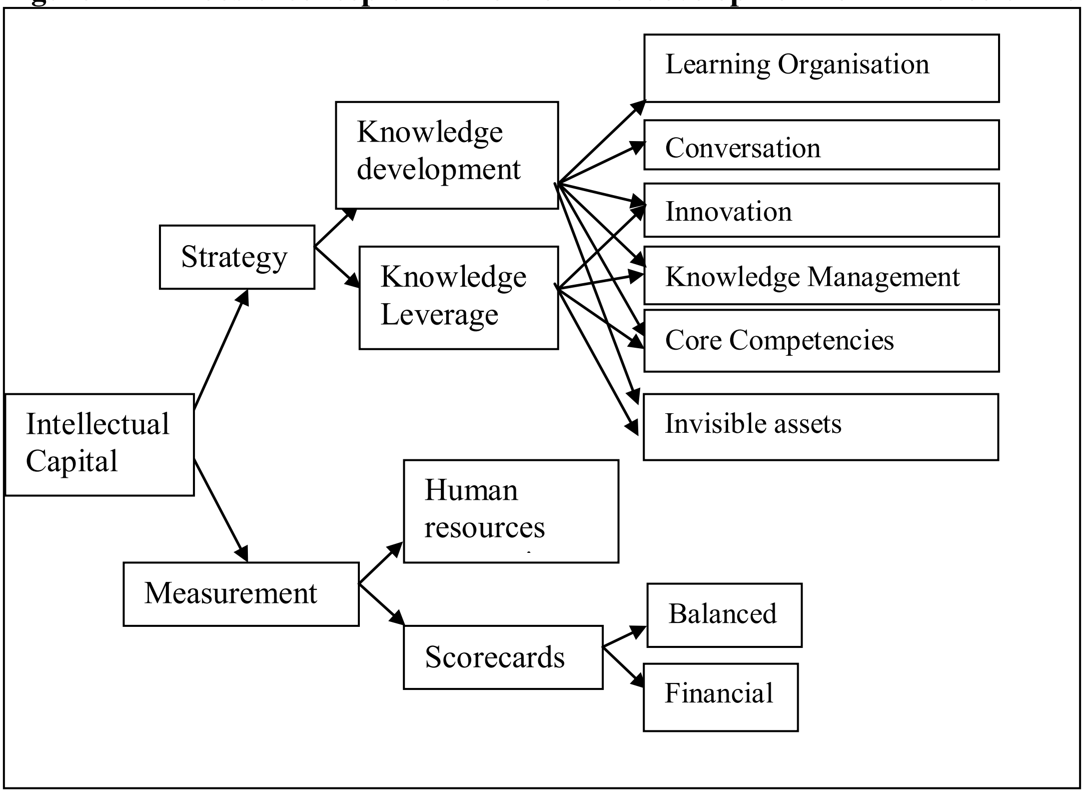
In the 1980's the strategic management field built upon the ideas of knowledge as a key factor of production to develop the "resource based theory", followed in the 1990's by the "knowledge based theory", to challenge the traditional "market based theories" (Marr, 2005). The "knowledge based theory" suggests that a firm sustains competitive advantage through possessing internal resources that cannot be imitated or substituted because they are mainly tacit in nature rather than explicit (Winter, 1987; Nonaka, 1994; Hamel and Prahalad, 1996). In a similar vein, Senge (1990) proposed that organisations that manage to thrive in "post tangible" economies, or knowledge based economies, are those that actively pursue continuous improvement in their "knowledge capital" as an objective. Economist Teece's (2000) work on "intellectual capital" contributed to the shift of emphasis for strategy development in businesses, from that of sustaining relative advantages between organisations to one of developing and utilising knowledge resources that an organisation generated internally.

In management science, Nonaka and Takeuchi (1995) see the purpose of corporate strategy as the conceptualisation of the kinds of knowledge that should be developed and used in operational processes as management systems for organisations to survive. During the same period Skandia, the Swedish financial service group, produced its annual report which included an evaluation of its not so visible "intellectual capital" in other words "knowledge capital" (Edvinsson and Sullivan, 1996). This was followed by the publication of a number of books on intellectual capital in quick succession by Edvinsson and Sullivan (1996), Brooking (1996), Stewart (1997), Sveiby (1997), and Roos et al. (1997).

At the macroeconomic level, in June 1999, the OECD convened an international symposium on "intellectual capital" with papers on preliminary results presented for discussion. The Danish Agency for Trade and Industry (1997) with European Union funding sponsored the MERITUM projects (2002) to develop guidelines on defining, measuring and reporting "intellectual capital".

Roos et al. (1997) categorised the development of the concept of "intellectual capital" into two branches as illustrated in Figure 2.1.

Figure 2.1: Roos's conceptualisation of the development of "intellectual capital"



Source: Roos et al. pp 15 (1997)

The first branch of strategy clusters concepts for the formulation of strategies by organisations to manage, develop and utilise knowledge within the organisation in response to a changed business environment. The second branch on measurement consists of emerging concepts for the measurement of resources including intangible ones for managing and accounting for the performance of organisations in monetary and non-monetary terms (Roos et al., 1997).

In economic terms, innovation in technology and globalisation raised the profile of knowledge and knowledge based resources as key factors of production. The importance of such knowledge based resources for the growth of organisations and economies raised the profile of "knowledge capital" (Winter, 1987; Senge, 1990; Nonaka, 1994; Teece, 2000). The porous contextual nature of these resources poses challenges for management and measurement strategies of organisations. Performance of organisation in monetary and non-monetary terms therefore evolved in attempts to encompass such resources. The following section therefore explores the literature on the nature and context of knowledge creation in organisations.

2.3.2 Knowledge creation in organisations

In the context of knowledge management, van Krogh et al. (1994) highlight that knowledge is shared within and between organisations through their history and experience. In a similar vein, Nonaka and Takeuchi (1995) and Blacker (1995) suggest that practical collaborations provide a platform for learning, a socially constructed understanding for generating knowledge in organisations. Within an organisation, Stewart (1997) sees “knowledge capital” as being generated when knowledge or intellectual material is formalized, captured and used to provide additional value to customers and organisation. The components and measure of “knowledge capital” in an organisation are thus defined by the context of its co-production with goods and services. Marr et al. (2003), from their survey study, found that the organisations that survive are the ones which are better than their competitors in the market at the transferring and sharing of a combination of public, private, organisational and individual knowledge.

In a business environment, knowledge that is dynamic and considered leading edge in the market during a point in time, on being used repeatedly and widely, becomes the essential and ultimately embedded knowledge of the future. Knowledge generated within an organisation may be explicit, that is codified in written form, or tacit within individuals’ heads, or both. This makes the sharing of such knowledge within the organisation and with those outside the organisation, complicated. Distinguishing the knowledge created within an organisation that can be applied to generate revenue or value for the organisation, therefore, is central to categorisation and measurement of the knowledge based resources jointly created. Understanding the course of service production and knowledge creation that occurs can thus provide insights for defining and measuring "knowledge capital" as a resource in an organisation.

In management literature, academics such as Senge (1990), Nonaka (1994), de Geus (1997) and Nevis et al. (1998) recognise organisations as learning systems that are capable of generating knowledge in the course of routine business processes. They see such knowledge creation in organisations as crucial for organisations to survive in a competitive business environment. Senge (1990) and de Geus (1997) focus on how organisations can support and shape human skills so that learning in the organisation can be encouraged, captured and embedded into organisational routines. Nonaka and Takeuchi's (1995) theory on the other hand is based on the principle, that learning in an organisation happens in a spiral between individuals and between groups, and sharing of such learning gets embedded into organisational routines.

The theory of knowledge[1] creating organisations (Nonaka and Takeuchi, 1995) widely cited in management literature converges with economists (Winter, 1987; Teece, 2000) views of organisations as repositories of knowledge, discussed further in section 2.4. This theory therefore provides a framework suitable for understanding the dynamic context for the sharing of tacit and explicit knowledge in organisations in order to achieve a shared purpose of service provision as detailed and discussed next.

Theory of Knowledge Creating Organisations

The theory of Nonaka and Takeuchi (1995) defines the patterns of interaction between tacit and explicit knowledge as modes of knowledge creation in an organisation. Such modes of knowledge creation are called, "Socialisation", "Externalisation", "Combination" and "Internalisation". "Socialisation" is described as a process of sharing experiences and observing processes which create shared mental models and technical skills, for example brainstorming camps and apprenticeships. "Externalisation" is seen as the process of articulating tacit knowledge into explicit knowledge in the form of analogies, concepts, hypotheses or models, through dialogue and collective reflection. The process of

1(Nonaka and Takeuchi, 1995, p. 58) "We adopt the traditional definition of knowledge as 'justified true belief.' It should be noted, however, that while traditional Western epistemology has focused on 'truthfulness' as the essential attribute of knowledge, we highlight the nature of knowledge as 'justified belief'… While traditional epistemology emphasizes the absolute, static, and non human nature of knowledge, typically expressed in propositions and formal logic, we consider knowledge as a dynamic human process of justifying personal belief toward the 'truth'."

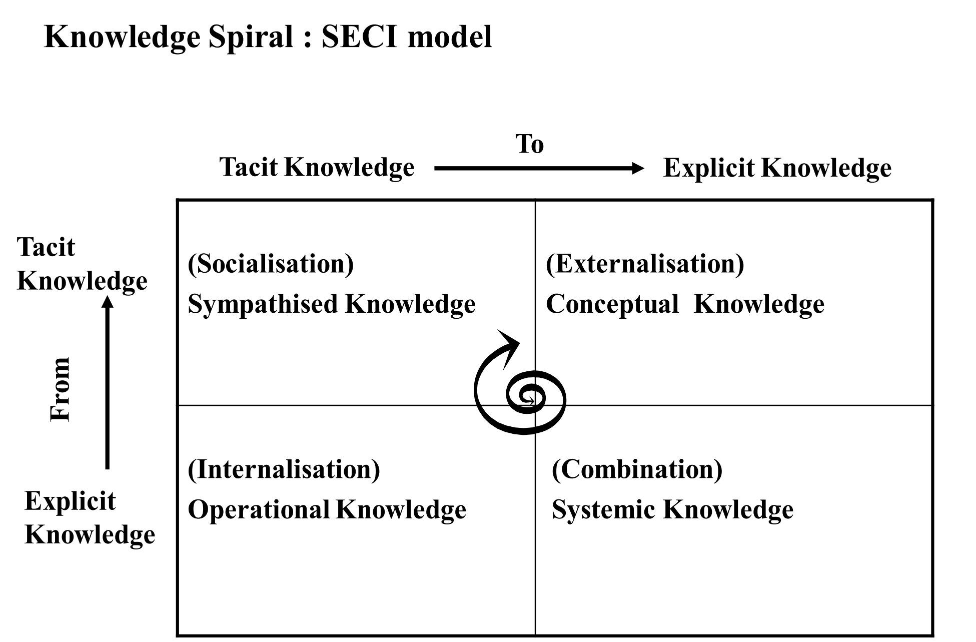
systemising concepts into knowledge categories by combining different bodies of explicit knowledge is called “Combination”. Some examples of “Combination” are reconfiguration of existing information derived from operational processes into business concepts such as databases, store loyalty cards, or product concepts like teleconferencing being converted into operational processes such as meetings across geographical boundaries. The mode of “Internalisation” is described as the process whereby the experiences from the previous three modes are internalised as individuals' tacit knowledge bases and organisational routines. This is similar to that of learning from performing a process, for example, where documentation of the processes can help individuals internalise the learning from the experience.

Nonaka and Takeuchi (1995) define “explicit” knowledge as something formal and systematic that can be easily communicated, expressed in words and numbers and shared in the form of codes, scientific formulas or universal principles. In contrast, “tacit” knowledge is defined as something not easily visible and expressible but within individuals’ heads as insights, hunches and mental models, making it hard to formalise, communicate and share with others (Nonaka and Takeuchi, 1995). Organisations in producing goods and services hence create and utilise the entire spectrum, from tacit to explicit, of knowledge and information.

Individual learning is seen as the foundation for knowledge in organisations. In their words, “An organisation cannot create knowledge on its own without individuals" (Nonaka and Takeuchi, 1995). They argue that organisational knowledge creation, therefore, should be understood as a process that amplifies the knowledge created by individuals and crystallises at group level through dialogue, discussion, experience sharing and observation within an organisation (Nonaka and Takeuchi, 1995). Further, such knowledge can become embedded in organisations as systems and routines (Nonaka and Takeuchi, 1995).

Knowledge is seen as similar to information in that meaning comes from, and is connected with, the context in which it is created (Nonaka and Takeuchi, 1995). Nonaka and Takeuchi (1995) see conversion of tacit knowledge to explicit knowledge and explicit knowledge to tacit knowledge, through the Socialisation, Externalisation, Combination and Internalisation (SECI) modes, as a spiralling process within an organisation, as illustrated in figure 2.2.

Figure 2.2: Nonaka & Takeuchi's knowledge spiral: SECI model



Source: (Nonaka & Takeuchi 1995)

The "SECI" model proposes that the transfer of tacit and explicit knowledge, in a shared context, is at the core of knowledge creation in organisations. Furthermore, they see the conversion between tacit and explicit knowledge occurring freely in the course of a process undertaken with some shared purpose such as problem solving. The "SECI" nodes of knowledge creation in an organisation are used to understand the elements of how, through sharing, tacit knowledge is made explicit and such explicit knowledge becomes tacit again through use. The conversion between tacit and explicit knowledge results in the spiral of knowledge creation where new knowledge is created within the cycles.

Nonaka and Takeuchi (1995) argue further that tacit knowledge gets transferred from individual to group as sympathised knowledge, as mental models and technical skills are shared between the participants in a face to face interaction, which encompasses the perspective and intention of the participants. Such shared knowledge is thereby externalised through the formalisation of concepts. Conceptual knowledge is thus available to combine with existing knowledge within organisational systems to become systemic knowledge. Systemic knowledge when used regularly gets absorbed as operational knowledge and becomes tacit as people and organisations internalise the knowledge. Such a framework therefore lends itself to a study of the creation and embedding of knowledge by individuals and organisations into systems and routines within the context of producing goods and services. In particular, the framework may be best suited for a study of knowledge based services, where both tacit and explicit knowledge are generated and used in the provision of services.

Nomura and Kametsu's (1999) work in Japanese on the SECI model used by Umemoto (2002) to study management of knowledge creation and its use in the following companies, namely Fuji Xerox, Sony, Hitachi and Eizai. He found that Fuji Xerox managed to externalise tacit knowledge gained from experience and convert it into explicit systems and routines for use in the organisation by sharing learning from successes and failures with current and potential customers (Umemoto, 2002). Hitachi, whereas, packaged such learning as a service product, for example the computer assisted engineering package on the internet (Umemoto, 2002). Sony's approach on the other hand routinely sponsored the development of new concepts, labelled "maverick", with the creator of the concept charged with bringing the concept to market, "play station" being an example of such a "maverick" (Umemoto, 2002). In Eizai, the fifth largest pharmaceutical company in Japan, the approach was to undertake focused projects with the aim of improving products and customer relationships through the capture of tacit knowledge by staff undertaking training in healthcare delivery at a hospital for the elderly (Umemoto, 2002). From the literature search, to the extent ascertained, health service provision had not been studied earlier through this framework.

Summarising, Nonaka and Takeuchi's (1995) theory of organisational knowledge creation links performance of organisations with the organisation's ability to capture and use tacit and explicit knowledge created in the production of goods and services. The theory therefore distinguishes between the nature and creation of both kinds of knowledge that is explicit and tacit, as a dynamic process within an organisation. Umemoto (2002) study of the dynamic context and processes within organisations that co-generate services and knowledge resources is facilitated by the model of a knowledge spiral. Furthermore, it demonstrates the varying ways in which organisations use knowledge resources generated by the active interaction of the tacit and explicit knowledge of individuals associated with the organisation.

"Knowledge creation" in an organisation can thus be described as the process by which knowledge, particularly know-how of individuals, is crystallized at group level through dialogue, discussion, experience sharing or observation and then amplified organisationally (van Krogh et al., 1994; Nonaka, 1994; Bontis, 2002b). Such knowledge creation processes used in the course of producing goods or services co-creates knowledge based resources in organisations. As Zack (2002) suggests, professional service organisations thus derive a strategic advantage from their ability to learn, accumulate knowledge from experiences and develop skills that enable the reapplication of the accumulated knowledge. The definition and nature of such knowledge based resources as a composite resource, namely "knowledge capital", also called "intellectual capital", from an organisational management perspective is further discussed below.

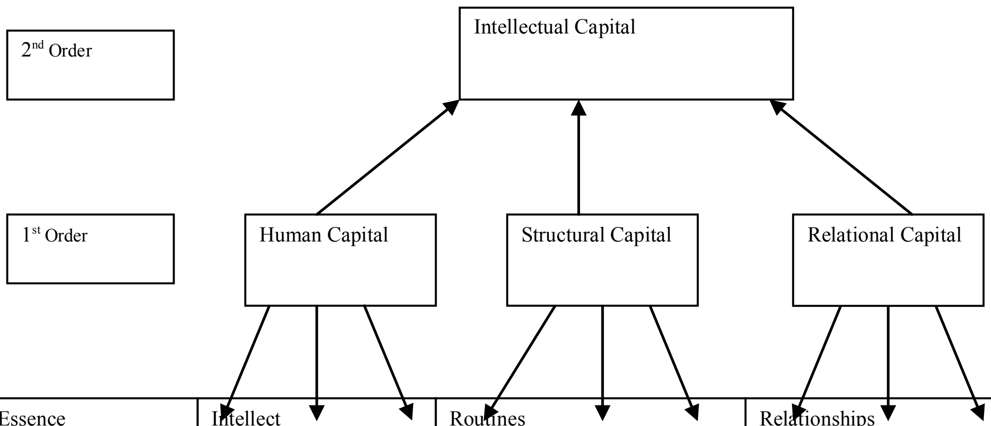
2.3.3 Definitions of "knowledge capital"

The definitions of the concept have been approached from conceptual and practical perspectives. Conceptual definitions echo Nonaka's (1994) thinking in defining "intellectual capital" as the invisible processes that are inputs and outputs of knowledge creating processes of an organisation together with the enabling conditions conducive to this process (Roos et al., 1997; Umemoto, 2002). They all highlight that the tangible kind of resource needs different management strategies from the intangible, which is related to knowledge created from external and internal relationships, structural and systemic routines and processes that help deliver routine tasks.

Nonaka (1994), Nonaka and Takeuchi (1995), Edvinsson and Sullivan (1996), Stewart (1997), Roos et al., (1997), agree that the intangible knowledge based "knowledge capital" is constantly being developed in organisations in the course of daily business. Starovic and Marr (2001) and Dzinkowski (2000) highlight, from a management accountancy perspective, that "intellectual capital" includes both the end result of a knowledge transformation process such as research or problem solving, and the knowledge that is transformed into tangible intellectual property such as patents. These conceptual and practice based approaches converge in defining “knowledge capital” as the shared context or environment and processes, be it physical, mental or virtual, where knowledge is created and captured through the facilitated interaction of tacit and explicit knowledge.

Bontis's (2002a) multidimensional construct of “knowledge capital” (Figure 2.2) encompasses the flow of knowledge within the firm and outside into the business environment. This approach (Figure 2.2) unpicks the component parts and the arrows attempt to demonstrate the functional disciplines' interactions through which "knowledge capital" is generated and utilised within an organisation.

Figure 2.3: Bontis’ conceptualisation of "intellectual capital"



Essence	Intellect	Routines	Relationships
Scope	Internal within Employee node	Internal organisational links	External organisational links
Parameter	Volume	Efficiency	Longevity
Codification Difficulty	High	Medium	Highest

Source: Bontis 2002a

This strength of this construct is that it highlights the stock of knowledge resources that is created from learning being embedded as organisational knowledge, systems and routines. The arrows categorise the resources created into "human", "structural" and "relational" based on the core essence of the resource. It describes what the economists Winter (1987) and Teece (2000), discussed further in section 2.4, define as a stream of economic profit that is derived from using distinctive process knowledge acquired through experience that can be tacit in nature. This construct while clarifying the multifaceted nature and scope of the resource, does not provide insights on how the component parts that yield value can be defined and measured in economic terms. Such definition and disaggregation highlights the challenges posed by the multi-faceted nature of this composite resource and the need to understand the context in which the component parts are generated in order to define, measure and manage this resource.

From a practical perspective, Skandia's report defines “intellectual capital” as “the possession of knowledge, applied experience, organisational technology, customer relationships and professional skills that provide it with the competitive edge in the market” (cited on pg 6 by Starovic and Marr, 2001). Echoing this, Mouritsen et al., (2001) conceptualises “knowledge capital” in practical terms as relating to activities managers undertake to manage knowledge, which are often about employee development, organisational restructuring and market development activities. Braunerhjelm (2000) defines the “knowledge capital” more appropriately from a long-term perspective as accumulated assets in R&D, marketing, software and education, where the returns are used by the firm themselves. The nature of such knowledge assets created is therefore partly codified and accessible externally, while the remainder is tacit and firm specific making them not very visible and difficult to measure.

In summary, several related terms are used, such as "knowledge capital", "intellectual capital", "intangibles", "knowledge assets" and so on in referring to the composite of knowledge based resources and capabilities of an organisation which may be intangible in nature but key for organisations to survive and grow in a competitive environment. The essential elements of these terms refer to the phenomena of "knowledge capital", also called “intellectual capital”. In essence, "knowledge capital" can be described as the collection of intangible resources gained through experience and learning and the use of such resources in the production of further wealth for the organisation (Nonaka and Takeuchi, 1995; Edvinsson and Sullivan, 1996; Stewart, 1997; Sullivan, 1998; Bontis et al., 1999; Edvinsson, 2002; Marr et al., 2003). In this context, Guthrie (2000), in a survey study, suggests that the distinction between “knowledge capital” and “intellectual capital” is sufficiently fine to be used synonymously.

2.3.4 Public sector management

In the context of public sector management, studies of “intangibles” were commissioned in Denmark (DTIDC, 1997) with a view to gaining greater understanding of how to retain staff and their knowledge within the public sector. These studies on “intangibles” undertaken in public or private sector organisations, state and local government in Denmark (DATI, 2000) supported the creation of policy statements on “intangibles” and knowledge management. As Mouritsen et al. (2004) found these were created with a view to safeguarding knowledge and employees within public sector organisations from a move to the private sector resulting from the shift to a knowledge economy. Following this European Union funded projects collectively called "Measuring intangibles to understand

and improve innovation management" (MERITUM) projects were initiated to develop guidelines for reporting “intangibles” also called "intellectual capital" in non-monetary terms as detailed later in section 2.5.3

Mouritsen et al. (2004) found that developing policies on "intellectual capital" within public sector organisations served as a mechanism for the development of strategy for each of the individual institutions. Furthermore, such policy development enabled accountability by establishment of distinct identity and performance goals for these institutions, separate from other public institutions with similar operations. The institutions thereby were required to deliver within a performance management manifesto containing financial, productivity and customer satisfaction targets wider than those statutorily required by private organisations. Additionally, “intellectual capital” statements enabled public institutions to present their organisation as one where employees, resources and services provided were central and related to achieving their monetary and non-monetary objectives (Mouritsen et al., 2004).

Additionally, Leitner and Warden (2004) studied public sector research organisations that were required to produce "intellectual capital" reports by European reporting conventions. They found, that the main benefit of producing “intellectual capital” reports to these organisations was a better understanding of processes of production of knowledge within their organisation which were important for achieving organisational performance.

Earlier in the UK, public sector management underwent a reorganisation of management structures in the 1990s which separated service delivery functions from policy making. Following this, non-monetary standards for managing and reporting performance of the service delivery organisations were emerging, such as the “Patients Charter” for the NHS in 1991. The performance indicators included in the charter were patient satisfaction, waiting times and delivery of policy objectives, standards and measures again wider than the mainly financial measures used in the private sector. Though the performance measures are not categorised and clustered as in the “knowledge capital” framework, nevertheless they reflect the component parts of this resource. Wall (2005) from a survey study suggests that public sector organisations are ahead of the private sector in reporting outputs in non-financial terms because of these imposed standards. He furthermore suggests that public sector organisations are waiting for direction from a regulatory body or a readily adaptable framework to best channel this knowledge resource generated by these reporting requirements (Wall, 2005).

2.3.5 Summary of issues for organisational management

Much of the early academic and empirical research focused on defining "knowledge capital" and on the methods of classification (Brooking, 1996; Edvinsson and Sullivan, 1996; Sveiby, 1997; Roos et al., 1997; Sullivan, 1998). This created a discourse for communication of the importance of understanding the role of “knowledge capital”, also called "intellectual capital", in organisations (Guthrie, 2000). The need for organisations to recognize and manage this “intangible” resource in order to respond and compete successfully in the changing economic environment is strongly argued (Winter, 1987; Drucker, 1993; Stewart, 1997; Sveiby, 1997; Teece, 2000; Bontis, 2002a, 2002b). Nevertheless, there are challenges of conceptualisation and measurement of an intangible construct, establishment of the cause and effect relationship between the parts, and development of reliable proxy variables to measure and value the construct of "knowledge capital" (Bontis, 2002a; Mouritsen et al., 2004; Marr, 2005). Several similar classification frameworks are proposed but with different interrelationships between the elements of this resource which include human, organisational and relational elements (Edvinsson and Sullivan, 1996; Sveiby, 1997; Roos et al., 1997).

Academics and practitioners in strategy, research and performance management have focused on the need for organisations to improve the management, specifically of intangible “knowledge capital”, to enable better informed decision-making at strategic and internal operational problem solving levels (Nonaka, 1994; Steward, 1997; Sveiby, 1997; Roos et al., 1997; Guthrie, 2000; Marr et al., 2003). The significance of capturing and using knowledge generated in the course of business processes that is converting tacit knowledge to explicit actionable knowledge (Nonaka, 1994), is at the core of organisational growth (Steward, 1997; Sveiby, 1997; Marr et al., 2003). Marr et al. (2003) appropriately highlighted the role of “knowledge capital” as a framework for the representation of the business logic of the organisation in a knowledge economy.

In this regard, Marr (2005) rightly suggests that the accountancy communities have built upon their own knowledge base of external statutory reporting requirements and measuring assets based on historical outlay of funds. Examples include the reporting of “goodwill” and R&D investments both of which reflect in part the intangible and long term nature of benefits that derive from business operations (ASB, 1997; IASB, 2009b). "Goodwill" is derived at the time of sale and interpreted as the crystallisation of the value of the intangible assets of an organisation. The accountancy conventions on measuring and reporting internally and externally for resource use are discussed further in section 2.5 on measurement.

“Knowledge capital" also called "intellectual capital”, is a phenomenon described with an acknowledgement that separating its component parts is not always possible, raising challenges for its measurement. The interrelatedness of the component parts make it necessary to consider the different parts of the composite, to provide a view of organisational and economic performance that encompasses both the long and short term benefits. “Knowledge capital” can be defined from a resource based perspective as possessing mainly three components, namely human resources, organisational resources and relational resources (Edvinsson and Sullivan, 1996; Sveiby, 1997; Roos et al., 1997).

Human resources consist of the skills, know-how, experiences and competencies of staff in the organisation. Organisational resources consist of practices, routines, brand names and intellectual property that remain within organisations even when people leave. Relational resources represent the relationships between the organisation and its external stakeholders, for example, suppliers and customers.

The tacit nature of aspects of “knowledge capital” makes measurement of this resource in purely monetary terms difficult (Bontis 2002a). In order to develop methods which attempt to measure and support the management of this resource within an organisation it is necessary to study the processes by which this capital is created. Whilst there is no separate recognition of the value of “knowledge capital” in financial accounts, some research suggests that in the commercial sector capital markets use other channels of information and incorporate the potential value of such assets in their valuation of companies (OECD, 2006b). Choo and Bontis (2002) recommend triangulation of findings drawn from surveys of external reports with empirical data on user perceptions and quantitative metrics. The following sections 2.4 and 2.5 on economic perspective and measurement methods from economics and accountancy discuss this further.

2.4. **Economic perspective**

Economists study the production behaviour of firms, in other words how organisations use resources as inputs to produce outputs such as goods and services, for a number of reasons. Lipsey and Chrystal (2007) enumerated the reasons for economic study as, firstly, to predict how behaviour of organisations may change in response to a change in a given condition. Secondly, such studies aim to support organisations to make the best decisions by which to achieve organisational goals because economics is the study of the problems of using resources to produce goods and services as efficiently as possible to attain maximum fulfilment of society's unlimited demands for goods and services (Lipsey and Chrystal, 2007). To inform macro-economic policies economists adopt the societal perspective when studying the effectiveness of resource usage and the long term and wider benefits derived from such use. Management science, on the other hand, takes the organisational perspective focusing on the issues faced by organisations in managing its resources to maximise returns for the shareholders.

Both economics and organisation theory offer "resource – based" theory as a useful way to measure the growth and development of organisations and economies. In this theory, firms are looked at as both a combination of stocks of resources and as transformational flows of tangible, intangible and financial resources. In this context the "knowledge based" intangible economy differs from the agricultural and industrial economy, in that knowledge has replaced labour and capital as the prime productive resource for organisations (Winter, 1987; Stewart, 1997; Teece, 2000; Foray, 2004). Additionally, the capital generated by knowledge in economic terms is different from other resources such as land, labour and financial capital, which on increased use yield diminishing returns. As Teece (2000) and Foray (2004) highlight, however when a knowledge based resource is subject to greater use and managed appropriately, the returns often accrue at an increasing rate. The implication for measurement of knowledge based outputs as resources in economic terms is, therefore, explored in the following sections.

2.4.1 Economics of knowledge

Economic thinking, similar to management thinking, recognises that the routine activities of production of goods and services can lead to learning and the generation of knowledge (Winter, 1987; Tyre and Hippel, 1997; Teece, 2000; Foray, 2004). Foray (2004) suggests economists started with reducing knowledge production to the function of R&D by limiting such activity to inventions and innovations. In conceptualising knowledge as an economic good, Foray (2004) suggests knowledge is generated as a by product, in other words as a positive "externality", of the core activity of production or service delivery.

Knowledge generated takes the shape of knowledge of processes and routines, some of which can often be tacit in nature. Such co-production occurs even when knowledge creation is not the aim of production or service delivery (Winter, 1987; Teece, 2000; Foray, 2004). In an economic theory framework, knowledge and knowledge based resources exhibit the "public good" characteristics, posing challenges for the control and measurement of these resources (Winter, 1987; Teece, 2000; Foray, 2004). Additionally, as Burton-Jones (1999) and Buiges et al., (2000) highlight, the measurement of "knowledge capital" is dependent on the purpose of measurement, for example to measure economic wealth or in economic study of firm or macroeconomics.

Characteristic of "public goods"

Economists define the features of a "public good" as being non-rival and non-excludable in nature (Begg et al., 2008). Goods that can be consumed by a number of consumers without the value being diminished to any of the consumers are considered “non-rival” in nature (Begg et al., 2008). The non-excludable nature of “public goods” means that it is difficult to exclude completely the consumption of the good by users who have not paid for such goods (Begg et al., 2008). Knowledge once created, by its nature can be consumed by any number of consumers without its value being diminished or exhausted when freely accessible and not excluded. This makes knowledge inherently a “public good”. Nevertheless, in some instances, for example consumption of new specialised knowledge, it may be excluded in reality by the need to have pre-existing technical skills or resources.

Some knowledge can be rivalrous but not excludable as anyone can access it, but rival in the sense that possession of such knowledge creates an advantage over another who does not. In other words, whether it is possible to technically retain the material in a private way determines the level of non-excludability of the goods and services. For example, computer games are non-excludable as anyone can access software and with the right equipment can read how the game was created. As a result copyright laws have been created to make such "knowledge based resources" excludable and thereby a "private good". Such law means a person using the material illegally can be prosecuted and made to compensate the original creators of the material. Such knowledge based resources as computer games are thus made excludable by law, though not excludable in a technical sense. However, computer games as a resource is rival in nature as demonstrated by the large revenues generated by organisations, such as Nintendo and Sony, through the selling of such computer games. The challenge with knowledge based resources or "knowledge capital" is that it is inherently difficult to exclude because aspects of it are vested in people. The value in use of certain aspects of "knowledge capital" to that organisation can be potentially higher than that of another only if early privileged access to such resources is acquired.

Measuring the value of a good is complex, when it is non-rival and non-excludable in nature. For example, the benefits from innovation stemming from widely used basic scientific techniques can extend beyond those who have produced the innovation in the technique. This means benefits from knowledge extend beyond the producers of the knowledge to other recipients, whose numbers can be multiplied ad-infinitum geographically in space, and in time, making measurement of such goods difficult. Such extensions of benefits called “externality” are made stronger in the case of cumulative knowledge that is where knowledge builds. The cumulative nature of knowledge makes it a resource for consumption like a durable good (Machlup, 1984), by enabling people to take action with the knowledge created, and as an intellectual input to create further new knowledge to expand the knowledge base. Estimation of the values of all benefits accrued in such a situation is therefore difficult and can be unfeasible.

Difficulties in economic valuation of knowledge outputs

Foray (2004), highlighted some of the reasons for the difficulties in valuing knowledge outputs as follows. Firstly, the seller does not lose the knowledge even when shared or sold. Neither does the buyer need to buy the same knowledge again even when using it several times, but can only assess the value of the knowledge after acquiring it. In economists' terms it is "non-rival" in nature as, theoretically, many people can use knowledge without any additional cost of production, for the use by an additional agent does not imply the production of an additional copy of that knowledge. This is an extreme form of decreasing marginal cost with increase in usage, as the potential uses for knowledge may be infinite.

In analysing the sectors where rapid disclosure of new knowledge is predominant, Foray (2004) identified that knowledge creation is often organized into "knowledge commons" for greater concurrent access, reproduction and expansion, to produce knowledge that meets "public good" criteria that is non-rival, non-excludable and cumulative. Unlike other resources of production, increased usage of knowledge does not deplete it, but increased usage by managers, producers, researchers and professionals invigorates and refines the resource. Additionally, his analysis highlights the individual and collective dimensions of the feature of non-rivalry (Foray, 2004). First, an individual can use the same knowledge any number of times to reproduce action without any additional cost to the individual. Likewise, a number of individuals can use the same knowledge without depriving another of this knowledge. In both uses, the individual and collective, once the knowledge is acquired no additional cost is incurred for providing recurring uses. These features raise problems when attributing monetary value to knowledge based resources using marginal cost based pricing.

The marginal cost of the use of knowledge resource is nil and impossible to financially compensate for the potential infinite use of the same knowledge resource. Whilst the cost of usage may be nil, the cost of accessing, reproducing and transmitting the knowledge resource, may be high. Without the investment needed for individuals to understand and exploit knowledge, which Cohen and Levinthal (1989) call “absorptive capacities”, the value of non-rivalry of the knowledge may be nil in specialised areas such as science.

To achieve maximum efficiency in utilising resources for the creation of new knowledge thus, as reiterated by Foray (2004), the costs of all resources used in the creation of the new knowledge needs to be covered by the economic value of the knowledge created. To cover the costs of new knowledge creation, therefore, in some cases limited protection or excludability is provided through mechanisms such as patents, licenses and copy rights, as in the case of the pharmaceutical industry and computer games. However, when the knowledge concerned is elementary, such as a technique or know-how which is understood and used by a large community of people, the economic value is greater making the return on such knowledge greater. The problem affects not only scientific and technological knowledge but also knowledge expressed in the form of text in books, music scores, radio programmes and visual media. The dilemma is that, when curbing the use of knowledge by protection, the accumulation and collective progress of knowledge in that area by other new combinations is constrained curtailing the returns to society from such knowledge.

In these circumstances, as highlighted by economists (Winter, 1987; Teece, 2000; Foray, 2004), an economic issue is that of designing private incentives such as patent protection for such resources without limiting the social value that derives from free use. Such protection, whilst not limiting the social value, needs to create exclusivity rights as in the case of private goods. Increasing private value means restriction on use but increase in social value means free use, thereby implying a contradiction. However, due to the cumulative nature of benefits from knowledge the dilemma becomes focused on production of knowledge. In the case of explicit knowledge production such as R&D, the mechanisms often used are subsidies in exchange for full public disclosure, direct government production or intellectual property rights granting exclusivity for a period of time. These mechanisms attempt to address the apparent contradiction posed in managing knowledge resources which exhibit the "public goods" feature of non-excludability.

A certain level of natural excludability for the individual involved in the knowledge creation is provided by the tacit dimension of knowledge. Such excludability provides a source of income to the individual till such time as the knowledge is codified, articulated, clarified and formalised, thereby becoming partially non-excludable. However, organisations cannot use this tacit dimension as a mechanism to control access to new knowledge as staff in organisations can transfer such knowledge through conversation with networks outside the organisation. Additionally, technical and organisational procedures require some codification and formalisation as process knowledge needs to be shared freely between the various parts and sites of organisations. Such codification and formalisation makes explicit some aspects of the tacit dimension of knowledge generated in the organisation making such knowledge more widely accessible. These processes can act to generate and enhance the skills, knowledge, systems and routines in the organisation which as a composite is the "knowledge capital" of the organisation (Winter, 1987; Teece, 2000).

Nevertheless, the danger of how benefits from process knowledge can be reduced to what economists call "weakly persistent" is rightly highlighted by Foray (2004) in his analysis. For example, if the practice of a task is interrupted, deterioration in knowledge may occur from forgetting. In addition, obsolescence can also depreciate knowledge. Typically, new knowledge has a broad tacit dimension, residing mainly in people's heads, sometimes neither articulated nor codified. As a result of this, collective knowledge, which is accumulated within a group of people, can disintegrate on the break-up of that particular group (Foray, 2004). Investment in processes that review such knowledge may be necessary to maintain and refresh such knowledge in order to achieve efficiency in the longer term within a changing environment.

Individual & Organisational knowledge

In specialist professional service organisations, for example of clinicians, lawyers or accountants, Løwendahl et al. (2001) identify that new knowledge development creates value internally as the professionals' information base is enhanced by the daily processes of delivering professional services. Løwendahl et al.'s (2001) study categories three types of knowledge, namely information based, experience based and personal knowledge, as important for creating value at an individual level. At the collective level he categorises knowledge to include formal reporting structures, formal and informal planning, coordinating and monitoring systems (Løwendahl et al., 2001). The cumulative nature of knowledge generation for the individual and the impact in terms of increasing the "absorptive capacity" of an organisation (Løwendahl et al., 2001) thus generates long term benefits for the organisation.

In the market environment, competition creates an incentive for organisations to create new knowledge, whilst other organisations try to improve their performance through imitation, absorption and adaption of a successful new idea. Therefore, Foray (2004) suggests organisations in a competitive market invest in "absorptive capacities" in order to benefit from involuntary knowledge spillover at the industry level. Following on, he argues that in sectors such as education and health, which are not in a fully competitive market, diffusion of knowledge is less automatic and administrative measures will have less of an impact on diffusion when compared to competitive markets (Foray, 2004).

Wall (2005) takes a contrary view, on reviewing the reporting requirements of public sector organisations in the UK. He sees the administrative measures as having a positive impact on the diffusion of knowledge in the public sector compared to competitive markets. For example, following reform in public sector organisations in the UK like the NHS, education and the civil service, uniform standards for non-monetary reporting are part of the accountability and performance management framework of such organisations. Such data collection to a set of common guidelines could lead to wider dissemination of knowledge and create a publicly accessible knowledge resource. The frameworks used in the NHS are therefore considered in chapter 6.

2.4.2 Impact of learning on short term efficiency and long term efficiency

Tyre and Hippel (1997) and Foray (2004) rightly highlight that even whilst the manufacture of goods or the provision of service is the predominant motive, knowledge is created through people learning from doing or by using resources, in a production context. The specific physical context of the learning thus defines the nature of the knowledge generated. For example, activities such as the introduction of novel equipment, organisation or methods acquire potential value in terms of knowledge of production processes and innovation. There is potential tension and conflict between the doing and learning aspects of production activities, which may inherently limit the production of knowledge in the context of service provision.

The maximizing of learning benefits requires time for reflective practice, which implies reduction in the short term efficiency of the process of production of goods or services. However, research services and the embedding of learning from doing into systems and processes can lead to efficiencies in the longer term through better practice. Reflective practices are necessary to synthesise the new knowledge from such learning and for learning to be implemented and embedded within systems and processes of the organisation. The management of the tension between short and long term efficiency measures in production requires to be informed by some measure of value of the wide spectrum of benefits generated including the knowledge based outputs.

In an organisational context, echoing management science academics (section 2.3), Winter (1987) and Teece (2000) frame the knowledge based assets created from the sharing of learning that occurs in production processes, the capturing of such learning within routines of production and in systemising the processes and innovation in production, as "knowledge capital". Winter (1987) sees tacit knowledge of an individual through sharing becomes related knowledge, which can then be articulated by other members in the organisation. For example, technical knowledge of products or services may be shared between different technical departments.

In organisations, knowledge that can be articulated takes shape when members of staff are able to identify the source of a particular kind of knowledge or technical know-how (Winter 1987). Individual learning becomes group knowledge when shared and legitimized through dialogue and shared understanding between group members in an organisation (Nonaka, 1994; Tsuchiya, 1994), supported by information technology that encourages this sharing. The knowledge of individuals ranging from tacit to explicit and that of organisations become a key resource for the survival and growth of organisations (Winter, 1987; Nonaka, 1994; Teece, 2000). They emphasise, therefore, that the creation of new knowledge through systemic innovation is a crucial function of an organisation.

The tension between resource allocation for learning in the process of production and achieving efficiency in the short run requires managing. Investing appropriately in individual and organisational learning that occurs from the production of goods and services could serve to maximise efficiency for organisations in the long run by creating knowledge based assets or "knowledge capital" and growth. On the other hand, embedded knowledge that is not reviewed and refreshed could raise the risk of errors and create hidden liabilities for the organisation.

2.4.3 Knowledge assets and growth

The dramatic changes in the business environment, such as innovations in technology and the deregulation of markets, have made businesses review their strategy in terms of the skills and competencies required to survive and succeed. In other words, the "knowledge assets" required to face the new challenges. In this changed environment, as Winter (1987) posits, it is of strategic significance for organisations to understand the nature of knowledge assets for their survival and growth. The nature of these knowledge based resources, unlike tangible assets, means that potentially some of these can be voluntarily transferred through conversations both internally and externally. This is less true of tangible assets such as plant or equipment that have greater physical boundaries thus making transfer generally more visible.

The varying challenges for measuring and managing these resources was summarised by Teece (2000) through comparing the different characteristics of tangible and intangible assets (Table 2.1).

Table: 2.1 Characteristics of tangible Vs intangible assets

Characteristics	**Intangible-knowledge based asset**	**Physical- Tangible assets**
Publicness	Use by one party need not prevent use by another	Use by one party prevents simultaneous use by another
Depreciation	Does not “wear out”: but usually depreciates rapidly	Wears out: may depreciate quickly or slowly
Transfer Costs	Hard to calibrate (increases with the tacit portion)	Easier to calibrate (depends on transportation and related costs)
Property Rights	Limited (patents, trade secrets, copyrights, trademarks, etc.) and fuzzy even in developed countries	Generally comprehensive and clearer, more so in developed countries
Enforcement of property rights	Relatively difficult	Relatively easy

Knowledge based assets, unlike tangible assets, exhibit an aspect of “public goods” in that consumption by one person does not reduce value for the subsequent consumption and there are greater levels of non-excludability (Winter, 1987; Teece, 2000; Foray, 2004). These features create difficulties for measuring the economic benefits from these resources that spillover into the society.

In terms of depreciation, as explained in Table 2.1, whilst a knowledge based asset does not wear out physically like tangible assets, new knowledge creation can lead to rapid depreciation of existing knowledge which may not be visible, for example codes in the computer industry (Teece, 2000).

Knowledge based assets, for example checklists and templates, can be transferred cheaply and almost instantly within organisations or across geographical areas using information technology. Whilst IT facilitates the mechanics of transfer, the quality and use of the knowledge resource transferred depends on the capacity of the person receiving such transfers, to understand and absorb the tacit components embedded in it (Teece, 2000). In the case of knowledge based assets the transfer process is therefore more difficult than in the case of tangible assets as the context and assumptions need to be specified and understood by the recipient of the transfer. In some instances, this feature acts as a mechanism for excludability which can then make a non-rival good rival as for example some aspects of space technology.

Ownership and boundaries of assets are clarified under property rights. However, as Teece (2000) raises, in certain circumstances where opportunities for involuntary spillovers are greater there are issues in protecting knowledge based assets. In the case of tangible assets aspects of boundary and ownership may be relatively clearer and could offer better protection for owners. The protection for knowledge based assets created in the private sector can include a registered trademark or patents. However, the enforcing of these property rights can be complicated due to the non-excludability aspects of certain kinds of knowledge thus making them “public goods” such as scientific techniques and know-how (Teece, 2000).

As Teece (2000) recognises, while the knowledge and expertise of individuals is the grounding for knowledge assets, organisations shape these into competencies and capability by providing the physical, social and resource allocation structures such as offices, discussion and meeting spaces, information technology and human resources policies. In the context of resource allocation within organisations, the importance of knowledge gained from failures, such as approaches that do not work, in steering resources towards approaches that are more promising is further highlighted (Teece, 2000). Some practical examples are insights gained from evaluation of performance management, budget setting, customer feedback or complaints processes and knowledge management. These are essential for reducing risks associated with the resource usage and production of goods and services.

The features of "knowledge capital" discussed above, raise challenges in terms of measurement when compared to the measurement of a tangible asset. The understanding of the context in which this resource is generated thus becomes essential in any attempt to define, measure and manage "knowledge capital".

2.4.4 Macro-economic perspective - Innovation and growth in an economy

Economists (Winter, 1987; Teece, 2000; Foray, 2004) suggest that with knowledge becoming a key factor of production, the difference in productivity and growth in different countries depends on the country's capacity to improve the quality of human capital and factors of production. From the twentieth century onwards, the share of "intangible capital" within a country's stock of real capital increased with economic growth (OECD, 1996; Burton-Jones, 1999; Foray, 2004).

In measuring and reporting economic performance of an economy the Organisation for Economic Cooperation and Development (OECD, 1996), identified that not all investments and wealth created by new prospering companies could be accounted for solely by raw materials, fixed capital or managerial knowledge. It found that the outputs from "knowledge/ intellectual capital", also called intellectual assets, in the United States in 1995-2003, were roughly equal to the outputs from tangible capital at 10-11% of gross domestic product (GDP), though investment in tangible assets appeared higher and is discussed further in section 2.5. "Knowledge capital", called "Intellectual capital", was thus identified by OECD as being important for innovation, productivity growth, enterprise competitiveness and economic performance (OECD, 1999).

The OECD (2006a) estimated the contribution of intellectual assets towards growth in labour productivity to be equal to that of tangible capital. The impact of the implicit spillover of knowledge from production activities is not fully reflected in the reports of organisations, prepared under guidelines for external reporting, discussed further in section 2.5. Investments in "knowledge based resources" that support economic growth at the national level are thus potentially under reported as such investment is usually reported as revenue expenditure.

The OECD (1996), therefore, to develop policies for the regulation and development of innovation and economic development, commissioned a number of studies to better understand and measure the contribution of “intangibles” to economic growth. The macroeconomic studies identified “knowledge capital” as a source of future economic profit if firms could manage to some degree to retain and trade outputs of such knowledge based resources.

OECD (2006b) identified three common core features among the varying definitions of “knowledge capital” forming the basis for projects undertaken to measure such intangible resources and to understand and improve innovation management. The first is having the potential to be a probable source of future economic profit. The second is the lack of physical substance for the resource. Thirdly, it had to be possible, to an extent, for the firm to retain and trade the resource. . The OECD (1999) defined “intellectual capital” as “the economic value of two categories of intangible assets of a company: organisational (structural) capital and human capital. The likes of proprietary software systems, distribution networks and supply chains are included in “structural capital”, whilst human resources (staff resources), both within and external to the organisation, such as customer and supplier relationships are included in “human capital” (OECD 1999). These are collectively called MERITUM projects, discussed further in section 2.5.

2.4.5 Economists' perspective on "knowledge capital"

Economists (Tyre and Hippel, 1997; Foray, 2004) have long highlighted the issue of learning that comes from undertaking an activity. Maximizing learning benefits requires time and space in the course of production for reflective practices. Such practices may be seen to conflict with short run efficiency goals. Nevertheless, in the context of long run efficiency, capturing such learning benefits is critical for survival and growth in the changing knowledge based economic environment (Teece, 2000).

Winter (1987) highlights that knowledge based assets are created from the sharing of tacit knowledge between individuals associated with an organisation during the process of production. . An organisation with capability to absorb new knowledge, that is higher “absorptive capacity”, also has a higher propensity to utilise and disseminate knowledge generated (Winter, 1987; Cohen and Levinthal, 1989). Building on this premise, and similar to Nonaka's (1994) views (section 2.3), Teece (2000) recognises that it is organisational infrastructure that shapes the skills developed by individuals in organisations into competencies that then become embedded into those organisations. These factors provide the capability to survive and expand capacity to create wealth in the changed economic environment. Summarising, he defines “intellectual capital” as a composite resource that consists of the human aspect, the organisational databases, procedures and routines and the networks created through external relationships (Teece, 2000).

A knowledge based resource, when wide access to benefits from such resources is required or access cannot be restricted due to its generic nature becomes a “public good” (Teece, 2000). Additionally the lack of physical substance makes the physical boundary of control and ownership of such resources less clear and difficult to measure. The unclear nature of the boundaries and the ease with which information can be electronically transferred can potentially make unauthorised transfers out of an organisation much easier. Hence firms, in making resource allocation decisions, such as investing in staff training, have a dilemma as staff may leave the organisation taking the benefits of training with them. In this manner the outputs of such investments can be used by other firms without paying for such use. When the benefits of such investments can be non-excludable the incentive for organisations to invest in such resources is diminished. The issues of boundary, ease of transfer and clear ownership, make resource allocation decisions pertaining to aspects of "knowledge capital" complicated.

Analysis of the economic literature indicates that some kinds of knowledge and "knowledge capital" created are useful for the organisation, and though not always technically excludable provide competitive advantage if kept away from others. However, in the case of knowledge and knowledge based resources generated from public funds, for example basic sciences, the government may not want to exclude through law but, on the contrary, expect wide dissemination. Once a process or resource is patented or protected by law it acquires a monetary value that can be used for buying and selling of the resource. Lack of rivalry and lack of excludability are characteristics of "knowledge capital", raising challenges for measurement.

In terms of valuation, knowledge and "knowledge capital" therefore is easier to value when technically excludable even in instances when funders for the generation of such resources do not want these excluded. In such instances, valuation can be made using value in use as opposed to valuation in terms of cost of production. When something is not excludable and tradable, there is no traded value, in other words, value in use for measurement purposes. In valuing other such resources economists have chosen to measure them in terms of the cost of production as the most feasible option (McPake et al., 2002; Drummond et al., 2005).

The study of "knowledge capital" is therefore not only about the nature of the resource but also about the challenges in its measurement as discussed further in the following section 2.5. At a macroeconomic level, the spillover effect of knowledge creation, together with the raised role of knowledge in economic growth, necessitated the need for development of policy on measurement and management of the intangible resource "intellectual capital". The Danish government (1997) and OECD (1999) guidelines for reporting of the investments in "intangible" resources as distinct categories may provide a start for measurement and aggregation of such resources.

2.5. **Measurement of "knowledge capital"**

In Andriessen's (2004) words "what gets measured gets managed" and so arises the need for organisations to measure "knowledge capital" for managing performance. He suggests performance may be enhanced by translating strategy into action by managing intangible resources, monitoring the effects of action and evaluating the various courses of action. In his measurement Andriessen (2004) adopts a transaction based approach with the aim of determining a value for the intangible assets pertaining to a specific transaction. This price determination approach is similar to the approach used in traditional accountancy guidelines for the valuation of goodwill on acquisition or disposal of firms (ASB, 1997;

IASB, 2009b) further discussed in this section. Such valuations are based on present value of joint earnings from tangible and intangible assets (Andriessen, 2004; Drury, 2006).

The different functions within an organisation view and measure the intangible resources generated within that organisation with different lenses as suggested by Bontis (2002b). The accountants' interest in measuring this resource is in terms of estimating the value of the resources of the organisation while information technologists want to codify and embed the knowledge resource into technical systems. At the same time, human resource managers and training and development officers want to ensure the development of human resources and show returns on the investment made in training and development of the resource. Within an organisation, the various disciplines identify values created using multiple measures which depend on the discipline and purpose of use. Nevertheless, organisations are required to report on their financial state to external stakeholders within statutory guidelines. Such guidelines are explored further, as these raise challenges for measuring and reporting this resource by organisations.

Simultaneously, economists' interest in "knowledge based" assets, as discussed in section 2.4, stemmed from the need to recognise knowledge as a factor of production. Economists encounter the challenges for measurement of this knowledge based output co-created in production of goods and services, which in part is not tradable and in certain circumstances non-excludable. The OECD (1996) developed policies and guidelines for reporting on "knowledge capital" at national level. The purpose is to measure the contribution made towards economic growth by innovation and investment in knowledge generation activities of organisations.

2.5.1 Accountants’ methods of measurement

In organisations, accountants measure the costs of resources for accountability, probity and governance issues and for financial planning and performance management purposes. Such estimates are based on historical outlay of funds by the organisation or explicit costs. In practice the cost of a product to the organisation is the cost of inputs for this product including a percentage of cost of joint inputs. The discipline of accountancy provides organisations with guidelines and principles on how to attribute monetary value to resources owned and used in the course of an organisation's existence. The statutory guidelines are provided so that organisations can report on the financial health of a concern to external stakeholders. Organisations have a statutory obligation to comply with these guidelines in reporting to external stakeholders. Management decisions, however, including resource allocation decisions in organisations use forward looking reports produced using management accountancy principles which include opportunity costs. The principles governing external and internal reporting of resources by organisations are discussed next.

Measurement for reporting to external stakeholders

As Roos et al. (1997) highlighted the advent of the information age in the mid 1980s brought to the forefront the gap between the values of assets accounted for and reported in the financial reports of organisations and the stock market values. Sveiby (1997) adapted the concept of Tobin's q[2] from accounting and finance literature to attribute this difference between the stock market value and the value of companies reported through financial reports, such as Microsoft and Netscape in 1995, to the value of "knowledge capital" embedded in the companies. The difference in values he suggests is based on the extent to which an organisation uses its embedded knowledge base. An example he uses is the case of the company Netscape, which ended the first day of trading in the market at a value of $2bn while posting negligible profits. Sveiby (1997) suggests that the market value was based entirely on its intangible assets, such as knowledge of IT processes. McKinsey's, the management consultancy firm, is another example used whose clients were willing to pay an annual rate of $500,000 per consultant for access to the firms' knowledge base (Sveiby, 1997).

Though not reported as such by organisations, the notion of measuring the value of intangible resources in business, however, has long been in use in accountancy and included in external reporting guidelines under various guises. Kaplan and Norton (2004) launched the concept of the balanced scorecard, to measure performance in non-financial terms, as a framework to develop organisational strategy. For example, generally at the time of sale of a business the financial state of an organisation is assessed and reported to purchasers in which the intangible resources are measured and often labelled generically as goodwill. The value of such resources is estimated as the difference between the value the buyer will pay and the value of assets reported in the books of the organisation. Organisations, when evaluating capital investments such as brands, where returns are generated over a longer time frame, use future returns incorporating qualitative factors to

[2] The Nobel Prize winning economist James Tobin developed this ratio to measure the relationship between a company's market value and its replacement value (i.e. cost of replacing its assets). Example a company with a stock market value of £100m and a book value of £50m will have a Tobin's q ratio of 2.00.

estimate the price of the capital assets (Mercer et al., 2002). The present value of future returns expected or required from such investment forms the basis of valuation of the capital asset.

In the UK, Financial Reporting Standards FRS-10 defines goodwill and intangible assets as non-financial fixed assets that do not have a physical substance but are identifiable and controlled by the entity through custody or legal rights (ASB, 1997). International accounting standards IAS-38, define intangible assets as an identifiable, non-monetary asset without physical substance, held for use in the production or supply of goods or services, for rental to others or for administrative purposes and measured reliably (IASB, 2009a; IFAC, 1998). In the USA the Accounting Principle Board guidelines APB-17 (APB, 1970), do not provide a definition for intangible assets. Internally developed intangible assets have to be identifiable, have a determinate life and be separate from the entity to be taken into accounted as an asset (APB, 1970).

Reporting Standards

The UK and the international accounting guidelines for external reporting do not make clear the distinction between intangible assets and "intellectual capital". For example, the guidelines classify patents, licenses, etc as intangible assets, which are the component parts of "knowledge capital" and which offer the organisation distinct form and control through legal rights. However, as discussed in section 2.4, those assets which are only partially excludable because of privileged rights of access to the knowledge based resources created by an organisation are not reported in external accounting statements.

The advent of organisations operating globally meant the International Accounting Standards Committee (IASC) was established through agreement between accountancy bodies of countries around the globe to develop accounting standards and guidelines for reporting the financial state of such organisations. The International accounting standards IAS-38 prescribes that organisations should recognise intangible assets (IASB, 2009a). Furthermore, the standard enumerates the principles that organisations need to use in measuring the value of such assets and report in the organisation's financial reports (IASB, 2009a). Other non-financial disclosures that are required to be reported, regarding this class of asset are also enumerated (IASC, 2009a). Traditional goodwill is, however, covered by International financial reporting standards IFRS-3 (IASB, 2009b).

The international accounting standard IAS-38, converging with FRS-10 in the UK, stipulates that the criteria for an intangible asset are: **identifiability** as a non-monetary asset without physical substance; a resource **controlled by the organisation** as a result of past events; and from which **future economic benefits** are anticipated (IASB, 2009a). These three criteria define intangible assets that require reporting under the accounting standard. When these recognition criteria are not met, the expense related to these activities are charged as an expense when it is incurred therefore such resources are not shown as an asset. The IAS-38 list of intangible assets is however broader than the list in FRS-10 and includes items such as design and implementation of new processes or systems, licences, intellectual property, market knowledge and trademarks, those that form elements of "knowledge capital".

The IAS-38 further prescribes that those intangible assets which have a finite life should be amortised over the life of the asset, not unlike depreciating tangible asset (IASB, 2009a).

Similarly, accounting standards require in the case of measuring intangible assets that costs of production or acquisition should be assessed and identified with the asset (IASB, 2009a).This requires that the historical cost of the asset be ascertained as a basic premise for recognition based on costs of inputs as a start. The standard also recognises that there may be deterioration of the value generating potential of the resource through obsolescence, or change in technology. In such circumstances the asset should be assessed for impairment, in other words, reduction in value and set against profit earned (IASB, 2009a). The values of intangible knowledge based resources, nevertheless, are not fully reflected in the books of organisations because of challenges of identification, controllability and estimation of potential future benefits.

There is agreement in the UK, USA and international accounting standards, FRS-10 (ASB, 1997), IAS-38 (IASB, 2009a) and APB-17 (APB, 1970) which provides a good start, although the definitions are narrow (Brennan and Connell, 2000). These definitions of intangible assets in these standards do not include elements of "knowledge capital" such as "human capital", "reputational capital" or customer loyalty except for some elements recognised at the time of sale or purchase of enterprises. As discussed earlier, what economists call "public goods" features of these assets, in certain circumstances (section 2.4), fall outside the controllable, identifiable and reliably measurable criteria that are required by the accounting standards. The prescribed criteria therefore does not allow for these assets to be included in the accounting reports.

Valuation of intangibles for external reporting

As per FRS-10 and IFRS-3, nevertheless, expenditure on intangible items forms part of "goodwill" on valuation of organisations for acquisition even though the criteria of identifiability and control are not fully met. The presumption is that the difference between the book value and what the market could command is attributable to intangibles (IASB, 2009b). The process of acquisition of a business quantifies some of the future benefits that could not be reliably measured earlier. Some of the intangible dimensions of "knowledge capital", such as customer loyalty and company reputation, when created externally are recognised in financial accounting at the time of acquisition of a business as goodwill and brand value. Valuations of such assets are based on the present value of expected returns from such assets.

On the other hand, any intangibles assets created through internal innovation or research are required to be charged as expenses at the time expenditure is incurred and are not reflected in the balance sheet though having future earning potential. The book value hence does not always reflect the value of additional assets that may be co-created along with the core purpose of service delivery or manufacture. For example, the economic value of research and innovation is not always fully reflected in the book value, as the prudence principle is adopted. The cost of inputs is thus used to estimate the book value of such assets. However, estimates of value based on potential future returns are adopted if such value is less than the cost of inputs.

Traditionally, financial accounting systems report the performance of an organisation at a point in time to external stakeholders. The financial reports generated from such systems do not provide sufficient information about values placed on intangible resources in managerial actions, as the reports simply comply with external reporting guidelines. Standards such as FRS-10 (ASB, 1997), IAS-38 (IASB, 2009a), APB-17 (APB, 1970), stipulate that only some of the intangible resources need to be capitalised and reflected in the balance sheet as an asset of the organisation. The financial reports generated for external use address difficulties in measuring tangible and intangible resources which can generate longer term returns that are not easy to measure by adopting a prudence principle. In practice, the lower of the estimates provided by different methods such as market value or cost therefore are used.

Summarising, accounting standards in countries around the world evolved from the need to set common rules for reporting the financial state of an organisation to external stakeholders. When organisations began to operate in global markets, international accounting standards emerged and the accounting standards in the UK, Europe and the USA began converging. The accounting standards bodies in the UK and the USA were building on existing standards and accounting frameworks for reporting on intangible assets as an amorphous term which does not recognise "intellectual capital" as such an asset. On the other hand, in 1998, the International Federation of Accountants (IFAC), classified "intellectual capital" as "human", "organizational (structural)" and "relational (customer) capital", similar to the definitions put forward by a number of writers (Stewart, 1997; Roos et al., 1997; OECD, 1999; CIMA, 2001; WHO, 2001). Management accountancy guidelines for reports produced for supporting management decisions is discussed further below.

Measurement for internal decision making

Academics in accountancy (Simmonds, 1981; Lord, 1996; Drury, 2006) recognise that management accountancy reports unlike financial reports are geared for supporting the development of strategy and for monitoring performance. These reports get embedded within the organisation's decision support systems in response to the dynamic business environment. The changes in business environment have meant such reports have extended to include external information on competitors (Lord, 1996).

In the context of reporting for decision making within organisations, the Chartered Institute of Management Accountants (CIMA) with its focus on supporting strategic management of organisations, invested and sponsored research into “intellectual capital”. Based on the research, technical briefings (CIMA, 2001) were issued on "intellectual capital" to guide internal reporting in order to support decision making in organisations. In these briefing, CIMA proposes measures for the three components of “intellectual capital” namely human, organisational and relational.

“Human capital” indicators include reputation of employees, length of experience, average years of service and proportion of employees in the organisation generating new ideas versus employees focused on implementation. CIMA proposes measures for "organisational capital" around R&D, innovation & product development, intelligence and information systems. Some of these R&D indicators include the number of patents, return on investment on the organisation’s patents, income per R&D expense, product life cycle, cost of R&D per pound sterling of sales and cost efficiency measures. Indicators put forward to measure innovation and product design include the numbers of multifunctional teams, product introduction per employee, trend of product life cycle and the average length of time from product design to development. The intelligence of the organisation is suggested to be indicated by numbers of databases, upgrades of such databases, and numbers of hits the databases receive. Indicators suggested for information systems (IS) are volume of usage, cost of IS per sale and satisfaction with IS services. The metric proposed for “relationship capital” includes customer satisfaction, numbers of complaints and number of long term customers and suppliers as a reflection of the value from effective external and internal business relationships (CIMA, 2001). The CIMA (2001) guidelines, whilst consistent with the external reporting guidelines, are more reflective and accommodative of the dynamic reality of decision making within organisations because of their use of qualitative factors.

Management accountancy principles, as highlighted by Drury (2006), support resource allocation by defining and measuring the costs of input and outputs of production and assessing such decisions from an organisational perspective. For example, one objective of management accounting is to assess the relative merits of choices that have to be made in relation to scarce resources used in production (Lord, 1996). For such purposes accountants classify costs in terms of cost behaviour into variable cost, semi variable or fixed costs, based on how costs vary with changes in activity and other qualitative factors (Drury, 2006). These methods of estimating the value of outputs from the cost of inputs of production are similar to those required by IAS 38 for external reporting purposes, as discussed earlier. Similarly, the methods used by economists in economic evaluation and in measuring the wealth of a country are similar and discussed later in the next sub-section.

Categorisation of production costs

The attribution of costs to the production of goods or service for the purposes of decision making is dynamic and takes into account the behaviour of cost, the relevant costs, sunk costs, opportunity cost, marginal and incremental costs. Costs, or in other words, monetary outflows that are changed by a particular decision, are called relevant costs. Organisations take management decisions by comparing the relevant costs with the relevant revenues, i.e.

monetary outflows and monetary inflows generated for the organisation by a particular decision. Evaluations of relevant costs and revenue in monetary terms are used when the impact of the decisions has predominately short term revenue consequences, what economists call short run. Nevertheless, for the financial survival of an organisation, decision makers attempt to match all long term costs with outputs generated over the short and long term. In practice, therefore, as Drury (2006) identified, qualitative factors that are relevant though not easily quantifiable are considered in the organisation's decision making. Such factors whilst considered in decision making are not readily visible in the monetary reports (Drury, 2006).

Some of the long term costs considered in decision making are called sunk costs (Drury, 2006). These are the cost of resources already acquired and are unaffected by the choice of the various alternatives (Drury, 2006). Marginal and incremental costs are the additional costs which arise from the production of an additional unit of output. On the other hand, opportunity costs measure the opportunity which is lost or sacrificed when choosing one course of action as opposed to an alternative course (Lipsey and Chrystal, 2007). Whereas, the opportunity cost of capital used inform decision making in organisations on a strategic level (Drury, 2006). The economic concept of opportunity cost in the organisational accounting perspective does not consider social opportunity costs or benefits beyond the responsibility of the organisation, which is at the core of macroeconomic policy evaluations and development.

Organisations, to address the challenges in measuring cost of shared inputs or joint outputs adopt a number of methods for costing inputs depending on the nature of the decision to be made such as pricing a job or product or capital investment. Methods used for costing can be based on a process, a job or a project, using standard costs for each unit of output or on actual monetary outflows and monetary opportunity costs (Drury, 2006). Process costing is used where the end products of the process are more or less identical. Job costing is adopted where a wide range of products or services requiring different levels of resources and specialisation are produced. In evaluating capital projects, capital assets pricing methods (CAPM) are used, which are based on expected future flows of revenue from a capital investment and the opportunity cost of capital (Drury, 2006). The opportunity cost of capital is based on the relation between the risk and return for such investments, also called the required rate of return or discount rate.

Allocation of costs of production

Organisations allocate costs into "direct costs", "indirect costs" and "overhead costs" to allocate and estimate the cost of a production. "Direct costs" are the costs of resources that are directly identifiable and are core to the product or service produced. "Indirect costs" are the cost of resources which are subsidiary to the main production or service delivery process and the resources shared by a number of activities, for example, the cost of maintaining tools. "Overheads costs" are costs that are not directly attributable to the product or service, examples of these costs are rent, rates, lighting and heating. To estimate the total cost of production, direct, indirect and a proportion of overhead costs are included. Overhead costs are apportioned, allocated or absorbed on the basis of appropriate input factors such as square footage, number of employees (Drury, 2006). The principle of internal control in accounting that serves external reporting guidelines ensures that allocated costs equal the total cost of production. In the developments of costing health services this principle is adopted and subject to statutory audit (DH, 2005a, 2007c, 2008a), discussed further in chapter 5.

Activity based costing (ABC), an adaptation of job costing, is a process that enables the overhead costs to be allocated by listing production processes, thus improving the accuracy of the cost data of a product by incorporating non-financial data (Schneeweiss, 1998; Gunasekaran, 1999). This costing process where all production processes and investment constraints are described acts as a planning tool and supports decision making in organisations, as observed by Schneeweiss (1998). In instances where a number of products are jointly produced, costs of the production of all products are jointly accounted in the books, till the costs for the different end products require separate resources and processes. All resources required for the production of all the end products and their attendant costs, are thus accounted for in the cost of end products. Though the costs are accounted for in separate streams for a period of the production process, other resources used jointly in production are identified and an appropriate cost attributed to each of the end products. This method may make feasible the identification, somewhat, of activities and attribute costs to different activities for production of joint outputs such as service provision and "knowledge capital".

Measuring resources from organisational perspective

In the organisational context, management accountancy techniques have evolved from supporting decision making in organisations, which needed to respond to the dynamic conditions of business (Simmonds, 1981; Lord, 1996; Drury, 2006). Management accountancy methods such as activity based costing are suited to accommodate the attribution of different kinds of costs to specialised and complicated production processes within an organisation incorporating qualitative factors (Schneeweiss, 1998; Gunasekaran, 1999). Disaggregating and attributing costs of production processes are informed by the short term and long term impact of the decision being made. Hence, as Drury (2006) indicates, in practice, decision making in organisations is informed by qualitative factors that may not be fully quantifiable, in addition to quantitative and monetary data.

O'Regan et al. (2005), in their study of reporting systems in the Irish information and communication technology sector, found that management accounting systems and applications such as activity based costing and rolling forecasts and estimates were used only moderately in informing key strategic decisions. It can thus be deduced that the management accounting systems were not being exploited to their full potential in the context of the impact of "intellectual capital" in key strategic decisions.

Furthermore, the issue of a corollary to "knowledge capital", that of "knowledge liabilities" of the organisation, rightly raised by Harvey and Lusch (1999) is yet to be addressed. "Knowledge liabilities" arise from the risk created from weak operational processes such as the improper storage of customer data, perishable products or inappropriate disposal of dangerous material. When deviation of processes or patterns from expected process or pattern is not captured and embedded in the organisational systems and processes, intangible liabilities may be created. These may take the shape of weak strategic planning processes, dangerous working conditions, poor corporate reputation or potential product or service tampering. Such "knowledge liabilities" are not reported on the balance sheet, but may need to be in order to provide a balanced position of the "knowledge capital" within the organisation.

An organisational perspective using internal management accountancy methods may be best suited for the study of "knowledge capital" created in an organisation. Some guidelines have been developed (CIMA, 2001) for organisations to recognise intangible assets in management accounting reports that support decision making. As organisations are operating globally, international accounting guidelines for financial reporting by organisations (IASB, 2009b) are being developed including IAS 38 for intangible assets. This standard does not accommodate the reporting of components of "knowledge capital", which are context related and may not be fully identifiable or porous and not fully within the organisation's control.

2.5.2 Economic methods of measurement

In economic evaluations, economists take a societal perspective in studying firms and measuring resources used and generated by organisations to support formulation of collective decisions for society (Lipsey and Chrystal, 2007). At the macroeconomic level, production behaviour is studied to evaluate how well firms use scarce resources from society's perspective. For such purposes, economists define the cost of input used for the process of production as what the firm must give up to use that input, which they call "opportunity cost" (Lipsey and Chrystal, 2007). In the case of inputs owned by the firm the minimum cost is, thus, the market value (Lipsey and Chrystal, 2007) similarly used by accountants, as discussed earlier.

Market prices with some adjustments are seen by economists as a good proxy for "opportunity costs" in a free market environment (McPake et al., 2002; Lipsey and Chrystal, 2007). However, as in the case of "knowledge capital" when the item is not fully tradable with difficult to allocate shared inputs or has significant externalities or is a "public good" or in the early stages of a product lifecycle, market price is distorted and not a good proxy. Further examples of when market price distortions occur are where the market consists of a single or a few powerful providers, or include third party payment system, government interventions or unstable market prices making estimation of "opportunity cost" challenging.

Economists call the relationship between monetary outflows and inflows, the "production function", considering the costs of inputs over three decision periods i.e. short run, long run and very long run (Lipsey and Chrystal, 2007). In the short run organisations make decisions on how best to employ their existing resources, whilst long run decisions require the evaluation of a choice of alternative resources and production processes within the constraints of known possibilities. The very long run decisions relate to policy at national level to encourage firms to undertake new techniques and innovations, which in turn generate skills, knowledge and capacity that form "knowledge capital" which spillover into the wider society (Teece, 2000; Lipsey and Chrystal, 2007).

The economic principle of "full imputation", states that for the proper economic valuation of a collection of resources, all the returns that are possible from that set of resources are taken into account (Winter, 1987; Lipsey and Chrystal, 2007). Economists, unlike accountants, measure costs not just in monetary terms but also in other types of resource for example, food, time, capacity, quality of life, productive life years. From an economist's perspective valuation of organisations, thus, require inquiry into potential future earnings and the possible sources for such earning power. In this context, the strategic role of competence and knowledge assets in the survival and growth of an organisation become significant. Therein lies some of the difficulties of measurement as highlighted by the valuation of some IT companies such as Microsoft, Cisco and Yahoo in the mid 90's and more recently, Google and Facebook.

From a macroeconomic perspective national income measures the factors of production in an economy for a period of time either through estimating the total flow of outputs such as goods and services or the total flow of inputs in an economy (Lipsey and Chrystal, 2007). Economists use two approaches to estimate national income, one based on inputs and the other on outputs. In the first approach, estimates are based on the cost of input factors and incomes earned such as wages, rent, interest and profit. The second approach is based on estimating the value of outputs of goods or services produced by organisations, as reported by them. The underlying assumption is that the value of outputs produced is equal to the value of income earned. Such an assumption holds when demand and supply in an economy are in equilibrium. In reality, the outputs are not often equal to inputs as the demand and supply of goods and services are not always in equilibrium.

The system of national accounts produced by the OECD (1996) reports on the economic activities of countries based on this assumption. The OECD measures the economic activities of a country by identifying all inputs of production within categorised sectors in the economy, then estimating the cost of the inputs for production of goods and services, to arrive at the value of outputs of the economy. The OECD (1998) found in the economic reports produced, using the 1993 system of national accounts sector categorisation that the investments in developing knowledge resources in the economy were not measured. In the period 1995-2003, the outputs from knowledge based capital in the United States were roughly equal to 10-11% of the country's total output or GDP, which was estimated to be the same as the outputs from tangible capital (OECD, 2006a). In the US economy, the contribution made by intangible knowledge assets to labour productivity growth was thus estimated to be equal to that of the contribution made by tangible capital (OECD, 2006a). In this context, Canibano et al. (1999) found that innovation or “knowledge asset” generation is commonly measured as an input measure using mainly the amounts invested in research and development. Patents granted are used as an output measure for innovation or “knowledge asset”. Any innovation within a firm that gets used internally, is not categorised as R&D, thus is not measured as “knowledge capital”.

The OECD, the Netherlands Ministry of Economic Affairs, the Ministry of Education, Culture and Science and the Nordic Industrial Fund in 1998 organised a symposium to bridge gaps in the reporting of the intangible resources. The symposium considered the possible gap between existing information and that needed on “intellectual capital” to support decision making on resource allocation and policymaking. As discussed in section 2.4, the Danish government had funded initiatives that resulted in the development and publication of “intellectual capital” accounts (DTIDC, 1997) for participating organisations. The European Union in order to develop guidelines funded an extension of the Danish initiative to include organisations from Sweden, Spain, Finland, Norway and France called the “Measuring Intangibles to Understand and Improve Innovation Management” - MERITUM projects, discussed in the following section.

2.5.3 Measuring intangibles to understand and improve innovation management (MERITUM) projects

One of the aims of the MERITUM projects was to provide a consistent basis for measuring and reporting intangible investments by organisations. As Canibano et al. (1999) identified such a basis for the measurement of intangible investments was to improve the policy making capabilities of the European Union in the areas of science, technology and innovation. The MERITUM projects were charged with the development of guidelines to measure and disclose information on intangibles which could in turn improve the decision making processes of managers and external stakeholders. The validity of the guidelines developed was further tested through the preparation of intellectual capital statements by the participating organisations.

The project was organised around four themes, classification, management control, capital markets and guidelines, all activities being undertaken by the six participating countries, namely Denmark, Finland, France, Norway, Spain and Sweden. A loose classification was devised to classify intangibles into human, structural and relational capital. The OECD (2006b) studies found that the experience of developing "intellectual capital" statements was different for the different countries, particularly in relation to supporting management control, as measurement of such resources was useful only when used for further management action.

Econometric analysis and case studies found that R&D and qualitative human resources had an impact on how the capital markets valued companies (OECD, 1998). Bukh et al. (2001), however, found that the guidelines proposed were based on an earlier project and though feasible for use by organisations, needed further development. The MERITUM project produced guidelines for systematically reading, recording and creating intellectual capital statements (OECD, 2006a). The taxonomy recommended for reporting under these guidelines (MERITUM, 2002) consists of "human capital", "structural capital" and "relational capital" to encompass, respectively, the human aspects, the processes and technological aspects and the relationship aspects of "knowledge capital".

The "intellectual capital" reports of participating companies contained different combinations of human resources, customers, technology and processes which formed the basis for the measurement of intellectual capital. The human resources category covered statements about organisational structure, management and satisfaction of staff. The customer category covered statements on spread, management and satisfaction of customers. The technology category covered the function and application of IT systems. The processes category covered statements on the scope, equipment and efficiency of business activities such as performance reports, risk assessment reports and equipment maintenance reports.

The nature of "knowledge capital" meant, as Mouritsen et al. (2001) found, the organisations that participated in the MERITUM projects gained varied valuable experiences and benefited from the process of identifying and reporting "intellectual capital". Furthermore, the participating organisations found the "intellectual capital" statements to be a systematic tool with which to understand which of these knowledge resources create additional value for the organisation (Mouritsen et al., 2001). In preparing "knowledge capital" statements, the participating organisations were prompted to work out strategies for identifying knowledge pools and knowledge generation bases within the business. In doing so the participating organisations created mechanisms to manage the knowledge assets generated within the organisation.

Leitner and Warden (2004) using the "intellectual capital" framework, studied a publicly funded research organisation, the Austrian Research Centres–"Seiborf". This study helps highlight that public finance funded research organisations, in other words "public goods", were increasingly being supported by funding from other sources such as contract research and donations (Leitner and Warden, 2004). Furthermore, it identified the spillover and interaction between the knowledge resources generated by self funded projects and research projects commissioned by external organisations (Leitner and Warden, 2004). Through this exercise, the research organisation found the interaction, between publicly funded and contract research, generated important additional values. The values to the organisation are in enhancing core research skills and other mainly intangible outputs, such as reputation or creating an environment that attracts staff (Leitner and Warden, 2004).

The Austrian Research Centres-"Seiborf" adapted managerial and accounting data to publish a report on the intangibles generated by the organisation (Leitner and Warden, 2004). The Austrian research organisations adapted internal management reports and external reports, through tradeoffs between these reports, to produce a report on "knowledge capital" that included research outputs and other intangible knowledge based outputs. The organisation's intangible outputs in the report were based on a categorisation system adapted from the MERITUM project guidelines. The report defines "knowledge capital" as the inputs for the knowledge production function of the organisation. Some of the outputs measured by the Austrian Research Centres "Seiborf" report are, to name a few, appointments to universities, number of patent applications, number of hits to the website by the public and number of spin off companies based on research undertaken in the organisation (Leitner and Warden, 2004). Some of the benefits of these outputs spillover from the organisation to the economy and the society at large, that is, contribute to the “public goods” component of "knowledge capital". Such benefits were measured using internal management data on additional projects and other revenues generated as proxy to estimate the value of the intangible benefits.

The OECD (2006a), however, raises some confusion about “intellectual capital” and “intellectual assets” by using the term "intellectual asset" to include all of the following, human resources and capabilities, organisational competencies (databases, technologies, culture, routines), and relational capital such as organisational structures, processes and customer and supplier networks, beside the traditional R&D, patents and trademark. The confusion arises as "intellectual assets" includes knowledge based assets like patents and trademarks, where property rights are protected by law and made excludable as discussed earlier in section 2.4. Whereas, “intellectual capital” is the greater composite, which includes intellectual assets, managerial capabilities and the capacity for implementing a strategy that generates value which may in part be non-excludable.

The categorisation of "knowledge capital" generated by the MERITUM projects, whilst developed for national accounts purposes, on balance has been successfully used in practice. It provided a framework to adapt data produced by organisations for management decision making and external reporting for the definition and measurement of "knowledge capital" generated in the organisation.

2.5.4 Measurement issues

Accountants and economists measure and cost resources utilised for production using similar cost concepts as reviewed in Table 2.1. The respective disciplines use the same terminology, such as costs and profits but with subtle differences in meanings depending on the focus of study.

Table: 2.1 Comparison of Economics & Accountancy methods

	Economics	**Accountancy**
Perspective	Societal Longer time frames	Organisational Short and long time frames
Costs	Cost incurred by user including opportunity costs to society	Actual monetary cost of production to the organisation
Indirect Costs	Cost to user in accessing product or service e.g. travel costs, time lost in travelling.	Monetary costs that cannot be identified directly to a particular product or service production called overheads e.g. rent
Intangible costs	Consequences of not having a service or product. e.g. Reduced pleasure from not being able to hear music one likes	Resources that can generate monetary value for an organisation but without physical substance e.g. patents
Profit	Total revenue minus Opportunity Cost	Total revenue minus Costs accounted for by organisation
Unintended benefits	Benefits generated that were not intended as part of the core activity- **Externality**	Subsidiary products produced through the production of the main product - **By products**
Nature of goods measured	Public and private goods	Mainly Private goods owned and controlled by the organisation
Reported as	National Income	Organisational income

Economists approach the measurement of resources from a societal perspective as economic evaluation aims to maximise societal benefits through policy. Economists, therefore, define cost in terms of the opportunities that are sacrificed when a choice is made. Accountants in taking an organisational perspective, for governance and accountability are constrained to measure resources based on historical cash outlay and the authority to manage the resource through ownership or other legal rights. Such are the guidelines for reporting the financial health of the organisation through statutory reports. For operational management purposes, management accountancy principles draw on the concept of "opportunity cost" in evaluating cost and benefits of investments. In practice, organisations in making resource allocation decisions, also consider some non-monetary and non-quantifiable qualitative factors like availability of key resources that may be in short supply and maintaining reputation (Drury, 2006). The impact of such factors in the decision making of organisations may not be visible when viewed from an external perspective or reviewing external reports.

Economists use cost to mean opportunity cost, whilst accountants mean the monetary outflow of the organisation. Unlike accountants, economists face no such constraint for the economic evaluation of policy. They often measure resource use and benefits in monetary and non-monetary terms from a societal perspective. Accountants in organisations measure cost mainly in monetary terms using management accountancy principles to support resource allocation decisions within the organisation and financial reporting standards for external statutory reporting. The terms cost, indirect costs and intangible costs are used by both the disciplines but used to convey different meanings.

Economists use the term profit to mean any surplus of revenue minus the opportunity cost of resources used, in other words “pure profit”. Accountants, whereas, adopt an organisational perspective defining profit as any surplus revenue to the organisation over the relevant costs accounted by the organisation in monetary terms.

Economists, taking a broader perspective, recognise that benefits from an activity of an organisation or individual can accrue serendipitously to those who have not paid for the benefit or for whom it was not intended. Such unintended benefits they call externality. The scope of economists' studies therefore includes production behaviour of organisations of both privately and publicly provided goods to maximise benefits to society as a whole (section 2.4). On the other hand, accountants measure any measurable outputs produced by an organisation which were not intended and refer to these as a by product of its main production. Any co-created product such as improved knowledge or capacity that spillover into society is currently not recognised or measured as part of the organisations' output. Organisations account for the output and costs of input to external stakeholders using reports based on statutory guidelines providing the basis for estimation of “National Income” or wealth of an economy.

Both disciplines recognise that the purposes of measurement and the context in which resources are used and generated, determines the scope and suitability of metrics for the measurement of a resource. The uncertainty of future benefits, lack of full control, absence of markets has raised challenges for the measurement and valuation of "knowledge capital" both from organisational and societal perspectives (Lev at al. 2005; Teece, 2000). Nevertheless, the importance of measuring knowledge based resources from an organisational management perspective is well recognised (Steward, 1997; Sveiby, 1997;

Bontis, 2002a, 2002b; Bukh et al., 2001; Marr, 2004). The need for corporate reporting to support the measurement of intangible resources at a national level is recognised and some guidelines have been developed (DTIDC, 1997; OECD, 1998; DATI, 2000). Though not definitive, economists and accountants (CIMA, 2001; MERITUM, 2002) attempting to define and measure "knowledge capital" build on the existing guidelines for measuring joint outputs and shared tangible resources based on input pricing approaches.

2.6. Synthesis of thinking from the disciplines of organisational management, economics and accountancy

The term “knowledge/intellectual capital” has been defined by practitioners and academics (Edvinsson and Sullivan, 1996; Sveiby, 1997; Stewart, 1997; Burton-Jones, 1999; Braunerhjelm, 2000; Teece, 2000) and is used synonymously by organisations in their reports (Guthrie, 2000). The initial literature on it ranges from intuitive understanding (Steward, 1997) of the concept to the development of frameworks for reporting and measurement (Edvinsson and Sullivan, 1996; DTIDC, 1997; DATI, 2000). Challenges are posed, therefore, by the diverse and multidisciplinary nature of the literature on the concept of “knowledge capital” particularly in bridging disciplinary silos (Marr, 2005).

The establishment of two specialist journals, such as the "Journal of Intellectual Capital" established in 2000 and the "International Journal of Learning and Intellectual Capital", as Marr (2005) suggests, are attempts to provide a consolidated channel for the emerging thinking on the subject. Published academic literature is largely attempting to build theory in this field. Many of the early frameworks developed by management practitioners appear to have been developed in tandem with and have been evaluated by academic work. Whilst a diverse range of communities and disciplines including management, economics and accountancy academics have contributed to the literature, yet there is no agreed method of categorisation and measurement of the different components of the knowledge based resource (Bontis 2002a).

Management and economics literature (Winter, 1987; Nonaka and Takeuchi 1995; Teece, 2000) is unequivocal in emphasising the necessity for an organisation's strategy to develop the capability to acquire, create, accumulate and exploit knowledge based resources that are created within the organisation. In doing so such organisations benefit from knowledge created in other organisations which is non-excludable and spills over into the wider economy (Winter, 1987; Cohen and Levinthal, 1989; Teece, 2000). Management strategies of organisations, therefore, require to be informed by the tradeoffs between open and controlled access to such knowledge based resources, to generate value from such resources. As a composite these resources, the "knowledge capital" of an organisation enables it to survive and grow in response to changes in the business environment, thereby improving efficiency in capital and labour markets (Winter, 1987; Hamel and Prahalad, 1996; Teece, 2000; Foray, 2004).

Early research focuses on defining "knowledge capital" and on methods for classification (Brooking, 1996; Edvinsson and Sullivan, 1996; Sveiby, 1997; Roos et al., 1997) with a number of studies endeavouring to define and develop metrics to measure "knowledge capital" (Edvinsson and Sullivan, 1996; Roos et al., 1997; Bontis, 2002a). In practice, Skandia as a pioneer developed "intellectual capital" reports to their Board, which raised the recognition and value of knowledge based resources co-created in production of services. The porous nature of these resources, as Starovic and Marr (2001) find, means statutory and compliance reports for external reporting do not provide management with the information necessary for the management of innovation and growth in a changing economic environment. Whereas organisations that prepared “knowledge capital” statements adapting MERITUM (2002) guidelines were found to absorb internally generated knowledge into day to day decision making (Mouritsen and Larsen, 2005). Nevertheless, with the exception of Marr (2005), the link between management strategies and the metrics used for measuring performance within the organisation is not fully explored.

Literature reviewed converges in defining “knowledge capital” into three broad categories namely, "human", "customer" (relational) and "structural" capital (Brennan and Connell, 2000). The relationships between the three categories are, however, presented differently in the various models derived in the literature. The approaches adopted broadly follow the notions of intangible assets as defined by IAS-38 (IASB, 2009a), with additional factors such as supplier customer databases and employer-employee relations included (Brennan and Connell, 2000).

Using such categorisation, as a start the potential values generated by investments in "knowledge capital" made by organisations are thus synthesised from organisational, industry and national perspectives in table 2.2. The organisational, national and global policy perspectives on investment in the various dimensions of "knowledge capital" require consideration, because of the overlapping functional capacity developed from such investments.

Table 2.2 Perspectives for investment in dimensions of "knowledge capital"

Perspective for Investment	**Dimension of "knowledge capital"**	**Output: Functional capacity developed**
Individual & **Organisation**	**Human Capital**: Individual Learning	**Competencies**: skills to respond and utilise changes in environment.
Organisations & Industry	**Structural Capital or National Capacity for innovation and service**: Organisational Learning, translated into routines, processes and systems, Research Capacity, Capacity for service development	**Organisational Capability**: organisational routines and systems to enable competencies in organisation to have flexibility and wider impact
Industries & National and Global Economies	**Relational Capital / Public Goods :** Dissemination of learning to external stakeholders and wider environment, impacts national reputation	**Organisational Capacity:** Widens scope of operation and impact and impacts organisational reputation

From this synthesis of management, economics and accountancy literature, "knowledge capital" may be summed up as the competencies, capabilities and capacity created in the capture, sharing and embedding of explicit and tacit knowledge generated through the core process of manufacturing products or delivery of services. Different definitions make a distinction between human capital, internal structures and external customer related capital (Brooking, 1996; Petrash, 1996; Roos et al., 1997; Sveiby, 1997) and lead us to categorise "knowledge capital" into "human capital", "structural capital" and "relational capital" (MERITUM, 2002; CIMA, 2001).

The value in "human capital" is seen as generated by the competence, attitude and intellectual agility of employees and the organisation (Winter, 1987; Nonaka, 1994; OECD, 1996; Roos et al., 1997). Nonaka (1994) and Teece (2000) develop the theme further by identifying that organisational resources shape individual learning and knowledge into competencies and organisational capability, also defined as "structural capital". The spillover of these resources through internal and external relationships into the industry adds to "national capacity". The strength of the internal and external relationships and reputation created during the course of business activities creates the capability of organisations to extend their capacity of operation (Teece, 2000; Hamel and Prahalad, 1996) also called "relational capital".

The nature of "knowledge capital" though generated within organisations, therefore, necessitates a certain level of public accessibility to generate "relational capital" (section 2.3.2, 2.4.2, 2.5.3). In this way, “public goods” are created called “public goods capital”, and industry capacity is generated from innovations resulting from the spillover of learning into the wider industry and the national and global economy. These characteristics of "knowledge capital" make part of this resource non-containable and non-tradable, which raise difficulties for measuring it as an output.

Measurement of this resource on the basis of the cost of inputs, as normally used by economists and accountants, although the most feasible still raises challenges of disaggregation of joint resource inputs. This is notwithstanding that measuring inputs can only truly reflect the value created in circumstances where resources are used efficiently, both in the senses of no waste and best use of resources. From an economics perspective, the OECD (1998) recognised this difficulty when using national accounts to measure the intangible investments made by countries. In 1999, therefore, the MERITUM projects were initiated to understand and develop guidelines for measuring and reporting such investments. The categorisation used is "human capital" "structural capital" and "relational capital" are also adopted by management accountants (MERITUM, 2002; CIMA, 2001).

Accountancy bodies have largely focused on accounting for the “intangible assets” to ensure consistency for purposes of governance in external reporting (IFAC, 1998, IASB, 2009a). Such guidelines therefore do not adequately address the difficulties of measuring internally generated intangible resources that are porous and not traded in the market. The Chartered Institute of Management Accountants in the UK (CIMA), however, in using the term “intellectual capital” in its guidelines, appropriately recognises the dynamic nature of this internally generated resource. It attempts to link the cash flows from these knowledge based resources with reporting performance in financial and non-financial terms.

The strategic role of management accounting in collecting and utilising data generated within an organisation, as Edwards et al. (2005) rightly highlight, can help understand and explain connections between aspects of "knowledge capital" within organisations. Additionally, the challenge for measurement from the lack of active markets of this internally generated resource can draw on methods based on input pricing approaches as in use for valuations of patents and know-how (Lev at al., 2005). Understanding and measuring "knowledge capital" generated within a particular context, therefore requires studies based on the organisation's internal management perspective (Rouse and Daellenbach, 1999; Marr, 2005) and adopted for this thesis.

2.7. **Conclusion- Scope and role of "knowledge capital"**

In conclusion, by bringing together literature from management, economics and accountancy this study highlights that benefits from knowledge based resources generated within organisations spillover into the industry raising challenges for measurement of this resource (section 2.3.3, 2.4.5). For the purposes of reporting, the "knowledge capital" of an organisation is categorised as "human capital", "structural capital" and "relational capital" (CIMA, 2001; MERITUM, 2002). These reflect the competencies, capability and capacity created in the organisation by the capture, dissemination and embedding of explicit and tacit knowledge generated in the course of production of goods or services (section 2.3.5, 2.4.6).

Both economists and accountants have developed guidelines to account for "intangible" resources, which are initial attempts to measure this resource. These guidelines (DTIDC,

1997; OECD, 1998; DATI, 2000; CIMA, 2001; MERITUM, 2002) developed for defining and measuring "knowledge capital" in external and internal reporting, could support further attempts to define and measure "knowledge capital" from the perspective of its management in the organisation (section 2.5.4). Tradeoffs between internal management reports and those for external reporting can offer insights into the production of "knowledge capital" within its context (Leitner and Warden, 2004). Public sector organisations with uniform standards of reporting on non-monetary factors (Wall, 2005) could be suitable for attempting to define and measure “knowledge capital” as a resource. This could enable an exploration of the definition and measurement of “knowledge capital” based on an internal management perspective as recommended by Rouse and Daellenbach, (1999) and Marr (2005).

The concept of “knowledge capital” in the context of health service could be significant as improvements in health service provision are dependent on the continual generation of knowledge (Good 2001) and its embedding into the systems and routines of health service organisations (DH, 2002a, 2006c; Newell et al., 2003; Currie et al., 2008). Furthermore, the nature of health service provision necessitates and results in wide access to benefits thus exhibiting "public goods" features in certain circumstances, for example, health related data, communicable disease control. The next chapter explores further the role of knowledge and challenges of measurement in the identification and measurement of “knowledge capital” in health service provision.

Chapter 3 "Knowledge capital" in health

3.1 Introduction

This chapter aims to build on the findings of chapter 2 by exploring the relevance and role of the concept of "knowledge capital" as a resource in the context of health service. The literature review in chapter 2 highlighted that "knowledge capital" is a knowledge based resource generated by the sharing of tacit knowledge by individuals associated with an organisation in the course of producing goods and services. The context of its generation provides the dimensions, scope and value of this difficult to measure resource. Understanding the context of health service provision is hence necessary to define and measure "knowledge capital" in health service.

Health service is a knowledge based service provided by the sharing of knowledge between patients and staff (Good 2001) with organisations providing the context and infrastructure for such sharing (Nonaka, 1994; Good, 2001; Chapter 2, 2.3.5). The critical role of sharing knowledge in health service provision was brought to the fore by the inquiry into high mortality rates at the Royal Bristol Infirmary, an NHS hospital in the UK (DH, 2002a). In this thesis, therefore the processes and resources used and generated in specialised health service provision are explored from an organisational management perspective.

Health services exhibit features of what economists call "public goods" in certain circumstances (McPake et al., 2002; Drummond et al., 2005), which in part are not fully traded and non-containable, thereby presenting similar challenges raised in the measurement of “knowledge capital” (Chapter 2, 2.3). Methods used by accountants and economists for the identification and measurement of all outputs of health service delivery, including any intangible outputs that may be co-created, are explored. The exploration seeks to help inform the development of a method and metrics to measure the components of “knowledge capital” in health service in monetary and non-monetary terms.

A strategic approach is taken in this thesis for answering the questions relating to the definition and measurement of “knowledge capital” in health as pertaining to an organisations’ managerial and internal resource allocation perspective. Using a managerial perspective can provide a practical platform for developing management strategies for health service organisations. With the long term objectives of the organisation in mind, such strategies ideally aim to better inform internal resource allocation decisions. Performance management of the organisation could then include the development and maintenance of knowledge based resources, parts of which can spillover into the wider health system.

3.2 Rationale and methods of literature review

In addition to the literature review on the concept of “knowledge capital” presented in chapter 2, a further review is undertaken to understand the role of knowledge and knowledge creation in the delivery and management of health service. Here the search strategy uses the following terms: “knowledge and healthcare management”, “knowledge capital and health”, “R&D and health” and “knowledge management in health", in searching databases. The keywords defined are informed by author's prior practitioner experience as a strategic financial management professional within the NHS and membership of an NHS R&D funding allocation working group. The advice of an information specialist informed the suitability of the search strategy, which resulted in the terms “knowledge management in health” being included in the search. The variety of terms used also reflects the close nature of the terms “knowledge creation” and “research and development” in the context of health service. The importance of knowledge management in the health service and the link with R&D management is thereby reflected in the range of literature searched.

The databases used for the literature search are EBSCO, CINAHL, Science direct, Emerald, Wiley Interscience, Ingenta, Health Management Information Consortium-Department of Health (DH)-Data and King’s fund database. Emerald publishes the widest range of business and management journals providing access to global thinking on management. Science Direct and Wiley Interscience are databases that provide access to a wide range of science and scientific management related journals. The Health Management Information Consortium (HMIC) contains the database of the Department of Health's Library and Information Services (DH-Data) and King’s Fund Information and Library Service. DH-Data contains official publications, journal articles and grey literature on health service policy, management and administration, with an emphasis on the British National Health Service. King's Fund is an independent health charity that studies and reports on the management of health and social care services and the reports maintained in the King’s Fund Information and Library Service databases.

This second literature search focused on knowledge in health, knowledge capital in health, R&D management and knowledge management. This is because the creation and capture of knowledge generated by the sharing of tacit and explicit knowledge within an organisation in the course of its business is central to the concept of "knowledge capital" (Chapter 2, 2.7). Key source books or papers are identified in the literature generated by the search and reviewed to help clarify and understand the context of their findings.

The search generated literature about R&D, knowledge creation, knowledge transfer in technology and other sectors. The literature found can be categorised into the disciplinary perspectives of information sciences, public administration, business management, including knowledge management, and medical and allied health sciences. The appropriate grey literature such as policy documents, strategies on R&D and financial management is also included in the review, based on prior practitioner experience in the NHS in the England.

The literature within information sciences was excluded as the technical development of IT knowledge management tools is not being considered in this thesis. Ethnographic, political science and sociology perspectives also provide contributions to the role and nature of knowledge in health service provision. The literature from these disciplines explores factors of power, politics in the process of health service delivery and knowledge management. These factors are not explored in this thesis as they are not considered practical within the time constraints.

The literature search identified seven papers with the search terms "intellectual capital and health service". Five papers found explored the concept of "knowledge capital" as a framework for managing resources in the health service, three in the American (Grantham et al., 1997; McGillis-Hall, 2003; Covell, 2008) and one in the Taiwanese context (Peng et al., 2007). Further four case studies were based in European health service organisations (Habersam and Piber, 2003; Mouritsen and Larsen, 2005; Zigan et al., 2009), exploring the nature of "knowledge capital" of these organisations. Mouritsen and Larsen (2005), studied the process by which Colopast, manufacturers of disposable care products, developed it's "knowledge capital" reporting statements. Habersam and Piber (2003) studied two hospitals, one in Italy and the other in Austria, their studies explored the relevance and awareness of "knowledge capital" as a concept in hospitals. Zigan et al. (2009) studied the perception of intangible resources and its management by hospital managers in a German university hospital. Knowledge, staff skills and experience were identified as important in hospitals (Habersam and Piber, 2003; Peng et al., 2007; Zigan et al., 2009), as was identified in other sectors (Winter, 1987; Nonaka, 1994; Hamel and Prahalad, 1996; Edvinsson, 2002). In the UK context, knowledge based issues in the delivery of health services are mainly addressed in NHS literature in terms of knowledge management and the terms "knowledge capital" or "intellectual capital" are not considered.

3.3 Knowledge in health service delivery

Health service is a knowledge dependent and knowledge intensive service (Good, 2001, Newell et al., 2003; Currie et al., 2008). The environment of health service provision is one of continuous evolution brought about by developments and discovery in science and technology. Furthermore, the changing life choices and preferences of patients have an impact on the ways in which health services are delivered. This constant change in the understanding of science and know-how brought about by developments, innovation and patient preferences makes knowledge a key resource in health service provision.

Good (2001), describes medical knowledge as a medium of perception and a mode of engagement with the world through a dialogical medium of experience, with encounters, interpretation, conflict and at times transformation. So the nature of health service, using Good's (2001) description, is such that, not just medical knowledge but also health knowledge of a more general nature, can be co-created in the course of service delivery. Health service in practical terms, as identified by a number of academics, can be seen as a social process of reflection and dialogue to make sense of the patient's health problem (Good, 2001; Newell et al., 2003; Fitzgerald et al., 2005; Currie et al., 2008). A shared sense of a patient's problem, through exchange and negotiation of knowledge between patients, clinicians and other groups of professionals or individuals, may help find solutions to the problem faced by the patient.

The knowledge accessed for this purpose can be from within the organisation and the wider health system. In the process of health service provision, clinical professional knowledge is used to address the health problem of a patient and find possible solutions that are preferably adapted to the patient lifestyle and preferences (Good, 2001). In this way, the knowledge of clinical staff delivering health service and the patients receiving care is potentially increased. The clinicians and patients are not always equal players and in some circumstances, it may not be appropriate that they should be, for example in medical crisis situations. Health service development, as seen by Clarke and Wilcockson (2002), is an iterative process between explicit research evidence, policy and knowledge of patients and local service systems. The generating and sharing of knowledge between clinical staff and patients is thus, as argued by Currie et al. (2008), central for effective and safe health service provision and developments.

The NHS, the UK health system, views the collection and synthesis of experiential knowledge of patients as an important part of the dynamics of the knowledge base for health (DH, 2005b, 2006b). The Department of Health (2005b, 2006b), sees the understanding and management of knowledge-based resources as critical for delivering effective and quality health services. In this context, as Newell et al. (2003) highlight knowledge management and getting new knowledge into clinical practice is linked. Furthermore, the transfer of new knowledge among service providers in health service is seen as more effective when knowledge of processes, in other words knowledge on ways of doing things, is transferred in the course of practice (Newell et al., 2009; Currie et al., 2008). This is so as the knowledge used by practitioners in service provision is context specific as earlier identified by Clarke and Wilcockson (2002). This knowledge is called “proximal knowledge” which comes from interaction with patients and colleagues in the course of delivering health service (Clarke and Wilcockson, 2002). Furthermore, they suggest that “proximal knowledge” is used together with adaptation of evidence and policy to understand local patient needs (Clarke and Wilcockson, 2002).

3.3.1 Knowledge management in health services

In the context of knowledge management in the health services sector, Currie et al. (2008) and Nicolini et al. (2008) identified that health service delivery is largely based on tacit forms of knowledge accessed through social processes rather than use of hardware or software. Nicolini et al. (2008) describe the processes of managing knowledge for health service provision as formal methodologies and techniques that facilitate the creation, identification, acquisition, development, preservation, dissemination and utilisation of the various facets of health service knowledge. Furthermore, they see the management of tacit and explicit knowledge of those providing health services as the essence of knowledge management in the health service sector. Currie et al. (2008) found health service professionals exhibited a preference for local shared tacit knowledge in making clinical decisions. However, informal practices and knowledge–rich data generated is often ignored by knowledge management systems and not used to improve management of health services (Nicolini et al., 2008). The tacit dimension of knowledge used in health service delivery can mean that the use of such knowledge based resources may not be immediately recognisable by those not familiar with the health service sector (Nicolini et al., 2008). Additionally, the role of patients in the process of knowledge generation and consumption is not adequately understood (Nicolini et al., 2008). Clarke and Wilcockson (2002) further argue that the advance of health service practice requires transfer of knowledge that creates a shared vision of service delivery with the patient at the centre of the process.

In the UK National Health Service, the critical nature of generating and sharing knowledge from best practice in health service delivery was brought to the fore by the public inquiry into the management of health service delivery for children with complex cardiac conditions at Bristol Royal Infirmary (DH, 2002a). Following the enquiry, the National Knowledge Service was established with the aim of providing evidence based healthcare information and knowledge to professionals, patients and public, and to facilitate the access and use of such knowledge in health and social care provision. The National Knowledge Service (2005) categorises knowledge in health and social services, into generalisable and particular knowledge for the purposes of managing knowledge generated in health and social care. Generalisable knowledge is seen as being generated not only from research or explicitly generated knowledge but also from routinely collected data such as audit, clinical activity statistics and data from patients' and clinicians' experiences (www. nks.nhs.uk/accessed in 2005). Data that relates to individual patients, clients, a particular health service or social service is called particular knowledge by the National Knowledge Service (2005). From a health system perspective parts of such knowledge and data are made widely accessible and form some of the "public goods in health" generated by service provision.

Nicolini et al. (2008) make similar classifications for data generated in health service provision around three themes. Firstly, patient data that is data relating to the state and history of an individual. Secondly, data on a group of patients regarding dates of admissions, of procedures undertaken, and scientific and epidemiological data is classified as management data. Thirdly, specialist disease data includes specific technical data relating to specific diseases including information on suitable drugs and side effects etc (Nicolini et al., 2008). The above three categories are the data that National Knowledge Service (2005) calls “generalisable” and “particular” knowledge. The distinction between information and knowledge in health service is highly problematic as highlighted by Nicolini et al. (2008). Furthermore, the fragmented and widely distributed nature of data and knowledge generated in health service provision is argued as a potential reason for the lack of its use in the management of service delivery (Nicolini et al., 2008).

Even earlier, Løwendahl et al. (2001), categorised knowledge created in organisations through service provision on a similar vein. Echoing economists (Chapter 2, 2.4), he suggests that in organisations that deliver professional services such as health services, value for individuals and organisations is created by the new knowledge generated from the processes of service provision. Furthermore, he suggested that the value created may not be distinctly visible or measurable as a resource (Løwendahl et al., 2001). The value of new knowledge generated is improved service delivery, as professionals' information base is enhanced from the learning that comes through the daily processes of delivering services (Chapter 2, 2.3).

In the context of professional service delivery, Løwendahl et al. (2001) identified three types of knowledge, namely information based, experience based and personal knowledge that are important for creating value at an individual level. At the collective or group level, he suggests that the knowledge includes formal reporting structures, formal and informal planning, coordinating and monitoring systems (Løwendahl et al., 2001). Categorisation of "knowledge" used by Løwendahl et al. (2001) is similar to the "particular" and "generalisable" categorisation used by the National Knowledge Services (2005), or patient, management. Similarly, Nicolini et al. (2008) categorise the same as specialist disease data. The individual and group level components of knowledge creation in the course of service delivery are highlighted by Løwendahl et al. (2001) and considered important in the health service sector by Nicolini et al. (2008).

A number of academics (Sandars, 2004; Gabbay and Le May, 2004; Dawes & Sampson, 2003 as cited by Nicolini et al., 2008), agree that practitioners make decisions in health services provision using tacit knowledge gained from their own past experiences often in order to make improvements in the care of patients. During the course of health service delivery Sandars (2004), sees work based learning in health care provision being generated through the mobilisation of tacit knowledge and its integration with explicit knowledge. Furthermore, practitioners in healthcare, in delivering services gain and use knowledge based on their colleagues' experiences through interaction with each other and from other sources of tacit knowledge (Gabbay and Le May, 2004; Nicolini et al., 2008; Currie et al., 2008). Knowledge acquired in this way can form the tacit guidelines used by clinical practitioners in an organisation, in other words the kind of knowledge that Clarke and Wilcockson (2002) call "proximal knowledge", and may not be fully reflected in what the National Knowledge Services categorise as "generalisable knowledge".

3.3.2 Research in health services

Buxton and Hanney (1996) earlier identified the role of explicit knowledge generation, or medical research and developments in the health service sector (HERG et al., 2008), as key to providing the evidence base for effective health service, development of skills and capacity and new service interventions. Ferlie and Wood (2003) identified that during the last decade in the NHS in the UK there had been an increasing move to commission and fund healthcare research, in other words generate knowledge that is of relevance to policy and practice. They suggest that in grant allocations, relevance to policy and practice is considered in addition to academic criteria. In this context, Currie and Suhomlinova (2006) suggest that raising the profile of research (knowledge generation) in health service, which focuses on patients may increase the relevance of findings to clinical practitioners. Furthermore, they found academics attempt to capture important tacit insights of care providers by interviewing or observing them and using such insight in interpreting the meaning of data collected for the research. Their argument that there is a risk to the quality of patient care when academic research in health is separated from clinical practice (Currie and Suhomlinova, 2006) is therefore strong.

Pharmaceutical and medical device organisations have had a long tradition of accessing knowledge generated by health service practice for developing their products. Nicolini et al. (2008) see the health service industry as located at the juncture of diverging, and sometimes contrasting, local and global interests because of the inherent “public goods” nature of certain aspects of health service and health knowledge. However, “specialist health knowledge” generated through health research projects, for example related to drugs and medical devices may be viewed by the individual or institution undertaking the research as a private good and may be protected by patents.

Factors such as the basis of funding provided to the individual or institution in which healthcare research is undertaken can determine the economic nature of knowledge created, that is as “public good” or ”private good”, as discussed in chapter 2, 2.4.1. Currie and Suhomlinova (2006) suggest defining knowledge as a private or public good is based on factors such as the level of knowledge sharing, which is influenced in part by culture and power base. The Canadian Institute of Health Research (2002) in acknowledging the value of data collected on patients as secondary data for research in policy, health trends and service developments, recognise the "public goods in health" output of service provision. As a result of exhibiting “public goods” features in certain circumstances health service has different challenges of management which sets it apart from other service sectors that produce mainly “private goods” (Nicolini et al., 2008).

In summary, health service provision is in essence a bundle of activities that draws on some of the existing concepts and experiential evidence while generating some new knowledge and adapting generic practice to individual need and preference. Health service delivery is based on both tacit and explicit clinical, non-clinical and management knowledge of those delivering the service. In addition, the accessibility of other available tangible and non-tangible resources such as beds, skills, specialist equipment, know–how and information has an impact on the service delivery. As highlighted by Tyre and Hippel (1997) and discussed in chapter 2, 2.4.2, people learn by doing or using processes in delivering services which in a healthcare setting means new knowledge being continuously generated for individuals and organisations through the processes of health service provision. In the health service context, academics (Newell et al., 2003, Nicolini et al., 2008; Newell et al., 2009) found that clinical staff exhibited a preference for use of knowledge generated by local experiences. Furthermore, they found that a preference to access such knowledge through social processes rather than using hardware or software was exhibited (Newell et al., 2003; Nicolini et al., 2008).

The sharing of knowledge in health service delivery has a critical role in the safety of service provision. For, understanding of the sciences of health is continuously changing through the process of delivering care. In a reflective professional environment practitioner knowledge could increase through better understanding of science and the experience of delivering care (Løwendahl et al., 2001). Ensuring the creation and capture of tacit and explicit knowledge in the course of health service provision are thus essential for both safe and effective provision of service (DH, 2002a).

Knowledge-rich data generated in healthcare, however, is often not used to improve management and service delivery as knowledge and information are difficult to distinguish (Nicolini et al., 2008). It could be argued that the delivery of safe health service and the evolution of better future services depends on the provision of an environment that enables sharing, reflection and capture of tacit knowledge generated in the process of service delivery (Newell et al., 2003) with the patient at the centre. In the course of service provision, thereby, skills and knowledge are enhanced and "public goods in health" co-created in the shape of data that is necessary for developing policies, research and service developments. Health service delivery and knowledge generation can, therefore, be seen as interdependent with such interdependency generating “knowledge capital” in the health services. The management of “knowledge capital” in health therefore becomes significant with a wider societal impact.

3.3.3 “Knowledge capital” in health: Management perspective

Though Guthrie (2000) suggests the distinction between “knowledge capital” and “intellectual capital” can be regarded as insignificant, the term ‘knowledge capital’ is used in this thesis to reflect the fact that knowledge creation and the use of knowledge is intrinsic to health service provision. Health service may be seen primarily to involve individual solutions based on technical knowledge, practical skills and know-how arrived at through human interactions. At the core of health service is human interaction that provides personalised interventions developed through understanding the perspective of the individual requiring service and the providers' understanding of available interventions and processes. Solutions generated in service provision, though based on generic sets of knowledge, require customising to the individual patient’s experience and context.

As discussed in the previous sub-section health services are knowledge based so the management of a health organisation needs to focus on managing the tacit and explicit knowledge used and generated by those providing the service. Echoing other academics (Chapter 2, 2.3.2, 2.4.3) qualitative study of “knowledge capital” in hospitals, see the organisation as creating the social and physical frame that enables the interaction between different professional knowledge groups and competencies for the delivery of service (Habersam and Piber, 2003; Zigan et al., 2009). They argue the different components of “knowledge capital” are connected together by the organisational management processes of service provision (Habersam and Piber, 2003; Zigan et al., 2009).

The first practical step, for an organisation delivering health service, is the interaction with the patient to capture patients’ experience into the records and systems of the organisation. Clinicians and administrators organise patient experiences, partially captured in tangible form as data, into formalised concepts such as patient history, disease symptoms, interventions, administration and billing. The capture of patient and staff experiences within the records and systems of the organisation thus converts tacit knowledge into codified data. By the codification process, data is synthesised into information enabling analysis, identification and sharing of the diagnosis with patients and other care providers in the shared context of health services and research. The most appropriate course of action, routines and processes of care delivery selected are adapted to the individual patient through clinical and management decision making. In choosing a plan of treatment for a patient, knowledge is created as new learning for patients and staff, either by reinforcing or by creating new insights and perceptions. Such knowledge in some instances increases local specialist knowledge and can become embedded in the organisation through conversion into guidelines.

The identification and sharing of specialist knowledge, such as nursing, pharmacology, physiotherapy and so on, are essential to establish the diagnosis, possible interventions, possible reactions and probable outcomes. When diagnosis and prognosis is established, a care plan is selected drawing on previous specialist knowledge and adapted to suit the needs and preferences of that particular patient. Examples of some of the mechanisms used in organisations for collection, sharing, synthesis and communication of knowledge are patient information systems, clinical rounds, multidisciplinary team meetings, clinical audits, research studies and patient forums. These organisational routines and processes generate data, which on aggregation become information providing feedback on the safety and quality of services delivered within the health system.

The knowledge gained through each service delivery contact within an organisation may remain anecdotal unless the different experiences are captured, formalised and organised into concepts of demographics, symptoms and diseases, for example in clinical grand rounds, clinical accident inquiries and clinical audits. The organised knowledge may help identify the appropriate people with whom this knowledge needs to be shared within the organisation. In this way specialist knowledge, for example, pharmacological, pathological, psychological and physiological, is identified in the health service systems and is accessible within the organisation.

A key part in the choice of treatment for a patient is the clinician's awareness of the patient’s wishes and interests, which may be tacit. Leatherman and Sutherland (2007) in their survey of patient experience in the NHS identified availability of information and involvement in care decisions as the top most priority for patients. The competency to capture such tacit knowledge can thus influence the effectiveness of treatment and the relationships between patient and clinician which in turn has an implication for the clinical reputations of staff and organisation. Sharing of tacit knowledge between clinicians and patient may also be inhibited by the unequal relationship in the service delivery process.

In this context, Leonard and Sensiper (2002) raised the issue that differential status between the doctors and nurses in health service delivery may act as an inhibitor to the sharing of tacit knowledge and thereby innovation. Currie et al. (2008), highlight that this unequal status between clinicians and patient stems from the fact that clinical staff in the process of delivering care interpret “specialist knowledge”, which they are licensed to use and adapt service to that particular patient’s requirements. In this regard they suggest that nurses may potentially be better placed to capture patient’s wishes (Currie et al., 2008), making development of cohesive multidisciplinary team working essential.

The Department of Health (1998b) in the UK, aiming to foster clinical excellence, required health service managers to manage the knowledge generation environment. This can be construed as an overt acknowledgement of the interdependency of effective health service and the need to manage new knowledge generated in the course of service delivery. Constantly evolving health technology and the need to synthesise new information has led to the “Information Strategy for Health” (NHS Executive, 1998) and the development of electronic health records to enable patient data to be held in electronic form accessible from a national database. In this context, Stefannelli (2001) found making information available to clinical staff in the form of guidelines, as part of a computer based electronic record had some impact on clinical care. Furthermore, Plaice and Kitch (2003) suggests that a drive for delivery of patient centred health service requires users of health services to make informed decisions by accessing current knowledge and information in the NHS. The introduction of Patient Advocacy and Liaison Services (PALS) has thus moved knowledge management issues higher up the management agenda within organisations in the NHS (Plaice and Kitch, 2003).

In the pursuit of evidence or explicit answers to a particular question in health care delivery, for example research into the impact of new or emerging interventions, the process is deliberate and systematic. On the other hand, new insights in health service are tacit and serendipitous arising from the routine processes of delivering care. The spectrum of tacit to explicit can be identifiable in both clinical and non-clinical aspects of providing care. Universities and teaching hospitals provide advanced codification of knowledge through teaching and research. In the UK, the Follet review by the Department of Education hints at the interdependency between knowledge creation and service delivery, by suggesting that in the performance management of clinical academics:

> "The substantive university contract and the honorary NHS contract for clinical academics should be interdependent (Para 41)" (Follet Review, 2001).

The Universities focus on the creation and transference of knowledge whereas the health service organisation focuses on productivity and effective delivery of health services. A tension as discussed in chapter 2, 2.4.2 is thereby created in measuring the performance of clinical academics who straddle both organisations. This tension, inherent in many service organisations is brought to the fore in health services where knowledge generation and service delivery are artificially separated because of organisational structure. Currie and Suhomlinova (2006) in studying knowledge sharing in the NHS in the UK, warn that the separation of academic research from clinical practice could be detrimental to patient care.

The Department of Health (2005b, 2006b), in the UK, through its research strategy, “Research in the UK”, has incorporated the development of knowledge management skills into strategies for clinical education. Furthermore, the importance of the NHS’s capacity to generate new knowledge at the personal, organisational and health system level is emphasised (DH, 2005b, 2006b). In the UK, the National Institute of Health Research (NIHR) was established with the aim of supporting the development of the research infrastructure to international standards and align research in health to national health objectives.

The NIHR is required to be a mechanism for effectively supporting world-class health research in the UK (DH, 2006b). The research strategy, discussed in more detail in chapter 6, aims to prioritise research that is aligned more closely with wider health objectives and helps translate the results of research into economic benefit. The integrated health system of primary, secondary and tertiary health service provision in the UK provides health related data of the entire population of the country which is suitable for health research (Black, 2003). The potential of such data to contribute to research on health outcomes (CIHR, 2002) makes it a "public good" that can generate economic benefits to the country through other sectors such as trade and industry as recognised by the Department of Trade and Industry (2006).

Pharmaceutical and medical device companies, in commissioning clinical trials in health service organisations utilise the research and knowledge generation capacity embedded in health service systems. These companies draw upon the codified knowledge and know-how gained by the clinicians and staff from treating a specific pool of patient population to inform the design and marketing of their products.

In the last couple of decades within the NHS, there has been a greater focus on the collection of service data to manage the performance of healthcare organisations, discussed further in chapter 6. There is increased emphasis on the use of patient experience (DH, 1989, 1998b, 1999, 2006c, 2008b), in the performance monitoring and development of health and social care. This highlights the importance of capturing patient knowledge of health service. The performance of organisations delivering healthcare is increasingly monitored in terms of appropriateness and quality based on current evidence, resource utilisation and availability of services to the public and patients. Such monitoring is undertaken using this data through processes such as clinical governance, healthcare performance review, audit and quality reports (DH, 1999, 2006a, b, c, 2008b). The processes of data collection and the need for accuracy have thus gained more prominence.

The knowledge gained from these monitoring processes when aggregated and shared may help further developments in health service. The Information Strategy and Knowledge Strategy within the NHS have been developed at different times. There is no overarching mechanism, however, that connects these strategies to the overall measurement of performance of NHS organisations, for the short and long run that includes both tangible and intangible outputs. Some of the outputs may continue to generate long term benefits, such as increased knowledge of staff, improved health services and knowledge of patients and carers, resulting from delivery of health services.

Additionally, the quality of service hinges on these knowledge outputs of the service providers being developed, maintained and widely accessible to yield benefits over the long run. Scientific developments and practitioner experience in the delivery of care further add to the dynamism of the knowledge base in health. Knowledge generation and processes of communication, which form aspects of "knowledge capital", are measured in the NHS performance framework by clinical audits and the volume of patient complaints upheld. These then provide a means of monitoring the effectiveness of the health services provided by the organisations in the NHS.

In the UK following the review of cardiothoracic surgery at Bristol Royal Infirmary, a "National Knowledge Service" for the NHS was established to support the provision of sound information for patients and staff. The service is expected to facilitate the coordination of publicly funded activities that generate, procure, organise, mobilise, localise or promote the use of knowledge (www.nks.nhs.uk, 2005). Currie et al. (2008) and Nicolini et al. (2008), however, found that the nature of clinical knowledge in health service is highly fragmented and distributed within health service organisations and the health system. This may be because of health service professionals' preference for shared knowledge gained from local experience (Currie et al., 2008).

Organisations in health service, when investing in staff skills that can help improve the quality of service delivery face the risk of "knowledge drain" when trained staff move to other organisations. In this context, recruitment shortages and retention issues within the NHS led the Department Of Health (2000) to identify education and research opportunities within a flexible learning environment as a means of avoiding “knowledge drain”. Furthermore, the development of Primary Care Trusts and mergers raises the danger of newly created organisations losing the histories of the previously separate entities. The continuing changes in the NHS focused attention on the need to create knowledge bases that could be managed effectively. NHS strategies, however, do not address the issue of tacit knowledge generation in the course of service delivery and its loss if not captured within routines and systems. Furthermore, NHS strategies address the issues of knowledge management, human resource development, information strategy and research strategy as separate streams, although their interdependency is crucial and key in the management of health service provision.

Health service is provided in a health system by a number of organisations, such as primary and social care providers, acute or secondary care hospitals and specialist and teaching hospitals. Each of these organisations can be best placed for generating and utilising different kinds of knowledge that emerge from the different nature of services provided. Within the system, knowledge created in teaching hospitals spills over to other health service organisations including acute care hospitals or primary care organisations and vice versa. This occurs as the patient's treatment progresses and continuing care is provided by the latter organisations. Collectively these organisations can potentially be seen as a knowledge creation network. In this way, some aspects of "knowledge capital" such as "human capital", "structural capital" and "relational capital", as identified in chapter 2, 2.5.3, may be present. These aspects may take different forms within the organisations in different health service settings and the network as a whole. There is therefore a macro-economic impact from the outputs of health service provision which extends beyond the organisation and which requires to be addressed in health system policies.

The major issue being addressed by health service organisations and systems, such as the NHS, is how to manage, steward and develop all resources, some of which are funded from the national budget. Knowledge based resources that constitute “knowledge capital” in health, therefore as Grantham et al. (1997) suggest, need to be managed for the benefit of the national population specifically and to enhance the global pool of “knowledge capital” in health services. Some of the knowledge based resources generated may be deemed competitive and organisations may be reluctant to share. Nevertheless, as Leitner and Warden (2004) found some conceptual knowledge may enhance organisations' "knowledge capital" through both internal and external sharing. Such sharing generates the organisation's reputation as a repository and centre of excellence in a particular area of expertise. Such expertise may then be sought by national and international industries, either for a fee generating revenue for the organisation or for free in certain instances.

Grantham et al. (1997) propose the concept of “intellectual capital” as a theoretical framework for managing knowledge based resources in the health sector at the executive and activity level of an organisation. McGillis-Hall (2003), using theories of "human capital" highlights “nursing knowledge capital” as accounting for productivity in nursing. Furthermore, see its generation from knowledge development in nursing staff an essential resource for safe and effective service provision.

Summarising, in health service provision the dynamic interaction between information and knowledge arises from the dialogue between clinicians, patients and administrators (Good, 2001, Newell et al., 2003, Currie et al., 2008, Grantham et al., 1997). The dialogue between clinicians and clinician and patient in order to find solutions to the patient's health related problem create the shared context, as identified by Nonaka (1994) and discussed in chapter 2, 2.3.2. Such a shared context enables the generation of knowledge based resources that constitute the "knowledge capital" of the organisation. The quality and safety of health service provision is dependent on effective sharing of tacit and explicit knowledge used and created in the delivery of health service (Newell et al., 2003, Currie et al., 2008) through the joint working of competent staff. Competencies of staff are created when learning and reapplying knowledge, which have been partly gained from experiences of health service provision. The environment provided by organisations for this learning helps develop the competencies of staff in service provision (McGillis-Hall, 2003; Chapter 2, 2.3.2). As discussed in chapter 2, 2.3.2, understanding the factors that create the shared context is important for knowledge creation, communication and embedding of the knowledge created into systems and routines of the organisation.

Health organisations within a health system use data from its systems and processes such as audit, patient forums and research studies, to learn from the service delivery and assess the safety and quality of services being provided. In the UK, in the NHS, the performance and service delivery by health organisations are monitored through reports following common guidelines (DH, 2006a). Such reporting by health organisations generates data and information related to health that is publicly accessible for research and policy making (Black, 2003) thereby creating a "public good in health" an additional dimension of "knowledge capital". The health system uses aggregates of this data to inform public health policies nationally and internationally and provide other "public goods in health", such as disease surveillances. Use of “knowledge capital” as a concept may lead to a framework for the identification and quantification of the intangible resources used and generated in the course of service provision.

3.3.4 Economics perspective

Economic evaluation of health service is concerned with maximising the welfare of the total society from the use of resources. Health economists viewing health service provision from a societal perspective therefore highlight that many positive externalities arise from such provision (McPake et al., 2002). For example, if one person is treated and cured of an infectious disease others are not infected. In addition, another important externality that arises for those in receipt of health services is called the “caring externality” by McPake et al. (2002). They define “caring externalities” as the concern some people in society have as to whether an individual gets the healthcare required by that individual. In this regard the public often appeal to raise funds either to enable an organisation to buy equipment or for another individual to receive health service. The significant number of charitable institutions in health can be interpreted as evidence of the high level of “caring externality” in health (McPake et al., 2002).

Narrower perspectives, such as a patient, purchaser or provider perspectives may be adopted to maximise benefits within a limited public budget. In this context, the tension and conflict that may arise between the doing and knowledge creating aspects of service provision surface, as the latter requires time for reflective practices. This conflict could inherently lead to a shifting of cost between patients and providers (McPake et al., 2002; Drummond et al., 2005) and limit the production of knowledge, such as research and development and service development, when there is a push for efficiency driven performance targets. As discussed in chapter 2, 2.4.2, maximizing learning benefits through reflective practices implies a greater tolerance to reduced efficiency of production in the short term. In the case of health service provision, the nature of the service makes learning benefits critical for the safety and reduction of risk in the service provided. The incorporation of long run benefits in efficiency targets is thus necessary for the delivery of safe healthcare and performance of health service organisations. The measurement of organisational performance therefore needs appropriate definitions of efficiency targets which are suited for the long run and straddles the health system.

Teece's (2000) thinking applied in the health context, means individuals associated with service provision learn and generate new knowledge in health, which increases their competencies and enhances the capacity of the health system. New knowledge generated in service provision when captured by organisations into processes, routines and systems enhances the capability of the organisation and spills over into the health system. In other words, the "knowledge capital" generated, including the "public goods in health" aspect, is part of the externalities generated from provision of services and research. The generation of "knowledge capital" in health, therefore impacts the economy's capacity for health provision and in turn growth.

Health service from an economic perspective shares with knowledge some of the features of "public goods" such as being non-rival and non-excludable (Chapter 2, 2.4). "Public goods" range from "pure" public goods that are both non-rival and non-excludable to private goods. Environmental health services and public health education are non-rival and non-excludable, making them "public goods". Examples of health services that can be classified as “private goods”, in other words rival and excludable, are hip replacement and cancer treatment. Some of the benefits of health services and health knowledge may be inherently non-rival, but in certain circumstances mechanisms such as patents or copyrights, or licenses to practice, can make health knowledge excludable (McPake et al., 2002; Chapter 2, 2.4). In addition, there are aspects of health service and knowledge that are inherently private that is rival and excludable but for various, often good reasons, may be given away free of charge. Examples of such services include immunisation, knowledge on infectious diseases and the onset of epidemics, as there are public benefits from the consequences of these services. Governments use subsidies and tax breaks to encourage organisations to invest in health knowledge generation and innovation and such knowledge is then made freely available.

In the course of service delivery certain health knowledge may be generated serendipitously rather than through explicit systematic processes making protection in such circumstances difficult. On the other hand, for instance in the case of drug developments, explicit processes are used and the knowledge generated is protected by patents making them excludable. The exclusion mechanisms of copyright and patents offer incentives for commercial investment in the development of new knowledge. In addition, as highlighted by Ghosh (2003), the lack of health systems to deliver the health knowledge generated and the lack of tangible infrastructure can often exclude the dissemination of benefits from medical and health knowledge. The complex issues around excludability of some aspects of health knowledge and knowledge based resources generated in health raise issues for protection and measurement, for example, knowledge in traditional systems of health service in certain countries like China, India and Brazil.

In the global arena when the benefits or disbenefits of an intervention in health care impacts health on an international scale, the interventions generating such benefits are classified by Woodward and Smith (2003), as “global public goods in health”. In the context of global public health Ghosh (2003), rightly argues for medical knowledge and innovation to be considered as “global public good” because of the many positive and negative effects of health care services impacting across national boundaries. She suggests "global public good" features of medical knowledge may necessitate the exploration of the extent of spillover across varying countries to ensure the efficacy of disease control across national and international boundaries (Ghosh, 2003). In this context there is provision within the global trade agreement “Trade Related Aspects of Intellectual Property Rights” (TRIPS), for excluding patentability of essential medicines on the grounds of public health benefits (Ghosh, 2003). A broader perspective is required for such policy as the benefits can transcend organisations and national borders.

From a macro-economic perspective, the WHO recognises research and development in health a driver for global health improvement (WHO, 2001). In this context it recommends that 5% of all healthcare resources be invested in operational research that examines efficacy, optimisation of treatment protocol, the economics of various interventions and delivery modes and population/patient preferences (WHO, 2001). This implies that investment is recommended both to increase the stock of knowledge and for enabling the process or flow of acquiring new knowledge in health, in other words aspects of "knowledge capital". Such combined investment can in turn increase the current stock of globally accessible knowledge. Additionally, as Cohen and Levinthal (1989) highlight, such investment could potentially improve the knowledge creating capacity and the capacity to absorb new knowledge in organisations. In the context of health, such increases in capacity occur partly due to the accessibility of the knowledge based resources generated by service provision spilling over into national and global health systems.

From a societal perspective health systems globally are aspiring to base policy and practice in the delivery of health services on sound science and research (DH, 2005b, WHO, 2001)). The potential for health services generating knowledge is recognised in research strategies and policies produced by health related government organisations in much of the world, including America, Canada, Australia, the United Kingdom, the European Union and the World Health Organisation (WHO). In the UK, the funds allocated to research in the NHS recognise the importance of Research and Development capacity in health service organisations and within specialist centres (DH, 1998a, 2006b, 2007a). Often specialist services start out as research programmes and become new funded and commissioned interventions. Furthermore, the significant economic potential of research in public sector establishments is recognised in the Treasury report by Baker (1999).

Taking a global perspective, Woodward and Smith (2003), in "global public goods" literature, raise issues for the World Health Organisation (WHO) and the developing countries in terms of the tension between vertically funded schemes, such as malaria, TB and HIV. However, Woodward and Smith (2003) suggest that horizontal issues such as the development of health systems or organisational infrastructure are required for the effectiveness of the vertical stream programme or disease specific programme. They highlight that the alignment of health systems to the local environment either compromises or enables the disease specific programme (Woodward and Smith, 2003). The impact on the health system of the "global public good" from the added value of the knowledge generated in health service delivery between developing and developed countries is an issue that remains to be explored. The questions of whether vertical and horizontal streams compete or create synergy or what other relationships are created between the two streams needs research which is outside the scope of this thesis.

The business environment for health service can be monopolistic or include few providers and third party payment systems. The service generates significant externalities and some "public goods" requiring significant regulation by Government. In this environment, therefore market prices are not good estimates of "opportunity cost" which is the basis for economic cost. Measuring alternate use of resources in terms of value to individuals in society for all alternatives is, however, not economically or practically feasible. The measurement of service provision based on the cost of inputs is adopted as the most feasible (Drummond et al., 2005). Measurements of core service transactions do not routinely take into account the side effects, such as knowledge generation or capacity development, on both production and consumption of health service. Such issues of measurement viewed from an organisation and policy perspective as encountered by economists and accountants in health are discussed next.

3.4 Measuring resources and benefits in health service

As discussed in previous sections health knowledge and knowledge based resources generated in the course of health service provision are difficult to measure as these do not have a distinct identity. Additionally, the co-production of "public goods" aspects of health services and knowledge based resources in health which are not tradable make measurement based on market price challenging (McPake et al., 2002; Drummond et al., 2005). Nevertheless, accountants and economists, in certain circumstances, use cost of inputs as a basis to measure the value of health services and parts of knowledge based resources produced. Health organisations are required to measure mainly in monetary terms the resources used, the outputs of such use and report to external stakeholders. Health economists, however, when using a societal perspective can measure resources used for providing healthcare and the benefits generated in monetary and non-monetary terms. The measures include cost, quality of life and improved capability of the individual receiving services. This section examines how resources are costed by accountants and health economists drawing out areas of convergence and difference.

3.4.1 Accountants' methods: Costing of health services

As highlighted in chapter 2, 2.5, organisations, including those delivering health services, measure the cost of resource use to support management decisions and financial control within the organisation. In addition, organisations are accountable in monetary terms to external regulators and stakeholders for the financial state of the organisation which is governed by statutory regulations as discussed in chapter 2, 2.5. These regulations aim to ensure consistency in financial reporting by organisations. Organisations in the commercial sector therefore manage health services by costing the inputs and measure outputs mainly in the form of revenue generated. However, health services are primarily funded through the public purse in many countries like the UK, Canada and so on.

In the UK, NHS provided health services are measured in monetary terms by costing the aggregate inputs and the outputs as revenue. Additionally, measurement in non-monetary terms is made using quality targets, ease of access, research and development and skills development as further detailed in chapter 6 (DH, 1998b, 1999, 2000, 2001a, 2006a,b,c, 2008b, 2010).

Organisations within the NHS are additionally required to have systems to provide patient level information and cost of healthcare treatments within stipulated costing guidelines (Chapter 5, 5.3). The guidelines provided by the Department of Health in the UK are in line with costing principles discussed in chapter 2, 2.5 (DH, 2007c, 2008a), aiming to allocate the cost of joint resources so that costs match closely to activity generating the cost. The costs of specific treatments in a particular organisation in the NHS in the UK are arrived at by cascading the aggregate cost of resources used for the treatments. The total cost of the treatment is then allocated to estimate individual patient cost using an average based on relevant activity, such as the number of times the patients come in contact with the local organisations, categorised for example as inpatient or outpatient (DH, 2005, 2007c, 2008a).

The costs incurred by a patient to get to the organisation or costs incurred outside the organisation however are not taken into account by accountants within the organisations. The costs not related to a direct flow of funds are not accounted for by the organisation under financial accountancy principles. Neither the costs incurred by those outside of the organisation nor the benefits that spillover to the wider industry in the form of knowledge generated, improved skill capacity or new external relationships created are directly considered by accountants. On the other hand, health economists when adopting a societal perspective in their cost benefit analysis of health services do include such costs based on "opportunity costs" principles in the estimation of the costs of health service and such benefits, as discussed later.

External Reporting

In the UK, health service organisations in the NHS are managed under public finance regulations set by HM Treasury. These regulations govern reporting to the UK Parliament on the resources used in service provision and the state of the health of the nation (DH, 1999, 2005c, 2006a) as discussed further in chapter 6, 6.2.2. Performance reports produced by NHS organisations, within such regulations, are consolidated to produce the NHS annual report and accounts and presented to Parliament. The performance management exercise within the NHS therefore attempts to estimate how the resources used by different organisations within the health service are being managed to produce optimal benefits for the population. In addition, as part of performance monitoring, NHS organisations are subject to value for money audits on the various aspects of service provision including research, staff education and training and patient satisfaction (DH, 1998b, 1999, 2006 a, b, c, 2008b).

There is currently no mechanism to provide commercial market values for all the knowledge based outputs generated by an NHS organisation. This is particularly true in the case of health service developments, skills development and research services provided by the NHS as a health system. Furthermore, the external accounting guidelines (Chapter 2, 2.5) for health service organisations do not currently accommodate accounting for such internally generated knowledge based outputs. Consequently, defining and exploring methods of measuring a key knowledge based resource, which is "knowledge capital", within the context of public sector organisations, becomes pertinent (DH, 1998; Baker, 1999).

Internal Reporting

Whilst external reporting requires compliance to statutory regulations, organisations use management accountancy principles for supporting resource allocation decisions (Drury, 2006). Management accountancy techniques such as cost benefit analysis are used to estimate the monetary cost of resources used to support decision making within the organisation. The benefits purely to the organisation are measured as output in terms of clinical activity and monetary revenues generated through providing the service. Internal management accountancy reports support the understanding of resource implications, for example by providing estimation of cost for delivering a new service or expanding capacity to support existing services (DH, 2003b, 2005a, 2007c, 2008a). For financial control and management of the production of services, organisations consider the costs incurred in providing health services, health knowledge and other benefits mainly in revenue terms and partly, in terms of reputations.

In estimating the cost of resources used for production of health service the cost of finance has been clear in commercial sector organisations. This clarity stems from these organisations' need to access finance in the open market and to rigorously account for the use of capital. The health service organisations in the UK are mainly publicly financed and public finance accounting conventions apply in estimating the cost of capital used. These conventions have evolved differently to those of commercial organisations, which have included the cost of capital used in production costs. Changes to public finance accounting since the 1990's in the UK brought the accounting for the use of finance in public sector organisations in line with commercial practice. NHS organisations are charged an annual capital charge as determined by the Treasury to reflect the cost of capital used. The rates charged are 6% in the financial years 1999 to 2004 and 4.5% from 2005 onwards. As a result, a return on capital has to be demonstrated by public sector organisations in capital or infrastructure project bids and for the use of finance in service provision. This has led to the cost of finance used being included in estimations of the cost of health service provision in the NHS (DH, 2007c).

The funding for research and development in the UK health service was reviewed by the Culyer (1994) research and development task force, which alludes to the embedded R&D infrastructure in health service organisations. This report found, much of the funding for R&D in the NHS, at the start of the review was bound up with patient care, teaching and other activities. It highlighted the difficulties in estimation and separation of costs of patient care, implicit research and development, and expenditure related to health service due to the intertwined nature of the activities (Culyer, 1994). The Culyer review (1994) started the process of establishing measures to cost, fund and manage both research capacity and the outputs from research & development in the NHS. Separating and measuring the cost of resources used for service delivery and explicit knowledge creation that is R&D, is challenging (DH, 2005b).

Despite this, the use of knowledge based elements that form part of "knowledge capital", although not always visible is partly recognised in research projects funding as contribution towards a proportion of institutional overheads (DH, 1997, 2005b, 2006b). The guidance on reporting research and development funding in the NHS is focused on clarifying research which is explicit new knowledge generation within the organisations that are eligible for NHS R&D funding (DH, 1997). Commercial and non-commercial organisations that commission research are required to reimburse any additional costs to service provider related to the research activity funded by these outside organisations. Healthcare providers are paid for treatment costs related to patients in research projects through service contracts (Culyer, 1994; DH, 1997, 2005b, 2006b). Additional patient support costs, such as extra blood tests and so on, that are attributable to particular research activities were not covered by R&D funding at the time of the Culyer review (Culyer, 1994) but subsequently covered (DH, 1997, 2005b, 2006b).

In the UK the performance of health service organisations is increasingly moving towards measurement in non-monetary terms such as patient experience oriented targets for achieving policy goals like reduced waiting lists, reduced waiting times and so on (DH, 1999, 2008b). Both the NHS and healthcare providers globally are facing ever increasing pressures on resources due to developments in science, technology and changing population demographics. Disentangling the cost of resources used for the joint products of health service provision is challenging (Culyer, 1994). Despite this challenge, organisations need to optimise both the short and long term benefits from health service provision. Cost estimation for investment strategies in healthcare therefore need to explicitly recognise and account for the long run impact of benefits derived from short run costs. Hence, there is an imperative to identify and measure all knowledge based resources created which act as inputs in the short run and continue to generate outputs over the longer run.

The method of identifying resource inputs using a service delivery perspective from those delivering the service can help with identification of the knowledge based resources being used and generated (DH, 2007c, 2008a). Recognition and estimation, to the extent possible, of the knowledge based resource generated in the course of health service provision using management accountancy principles, as discussed in chapter 2, 2.6, therefore could support the definition and measurement of "knowledge capital" in health.

3.4.2 Economists' methods: Measurement of health services

Health economists McPake et al. (2002), highlight that the spillover effects on both production and consumption of health services caused by the many positive externalities or additional benefits arising from health service provision, need addressing. McPake et al. (2002) explain that the individual purchaser, in measuring benefits, is not able to consider all benefits associated with the health service delivery. The individual considers only those benefits that are directly related to them, such as longer life, better health and higher personal productivity or reduced personal risk.

From an organisational or individual perspective, the difficulty in measuring these wider benefits constrains estimation of the money value of outputs. In addition, the organisational context of service provision, such as public or private sector, service delivery or research and development, impacts the manner in which the resources used and benefits generated are measured. The focus of an organisation's core activity in terms of service delivery and research will determine the allocation and categorisation of resources used between service provision and research or knowledge generation. When a purchaser or provider perspective is adopted, however, the estimate of costs of service provision purely as pertaining to the organisation is included, which may not account for any shifts in cost to patients or other providers (McPake et al., 2002; Drummond et al., 2005).

Health services when funded substantially from public finance raise further challenges in measuring a knowledge based resource generated partly as a good for public benefit. The challenges for measuring such resources are different from those faced in a commercial setting because of the "public good" aspect of the service. For example, health treatment such as immunisation where there are no artificial exclusion mechanisms and which is available free of charge may be difficult to measure in economic evaluation terms. On the other hand knowledge generated in the commercial setting and artificially excluded, may become a “private good” measurable in part by collective willingness to pay or the market price, which in a perfect market will reflect value to society.

In terms of measurement, economic evaluation as highlighted by Drummond et al. (2005) provides methods for comparison of the opportunity costs and the consequences of competing alternative courses of action. In economic evaluation, where a societal perspective is taken, the costs of resources utilised for alternative health service treatments or programmes are evaluated against the outcomes from these treatments or programmes. Economic evaluation methods used in healthcare to support policy and decision making include cost minimisation analysis, cost effectiveness analysis, cost benefit, or cost utility analysis.

Drummond et al. (2005) categorised health care costs, in economic studies, as direct healthcare costs, direct non-healthcare costs, indirect healthcare costs, indirect non-health care costs and intangible costs. They later reduced the five categories to three to avoid confusion with accountancy terminology. The three categories of costs are, those incurred by the health service sector, by patients and their family and those incurred in other sectors such as public agencies and the voluntary sector (Drummond et al., 2005).

Costs in the health service sector are of resources used by health service organisations, such as hospitals, to provide treatment to patients. Estimation of such costs is based on the number of days a patient is in hospital, treatments, therapies, special equipment and medical supplies provided to individual patients or for a health programme. Costs to patients and their family include items such as cost of house modifications, special diets, patient travel time, informal care from family, and psychosocial costs in terms of quality of life. Costs incurred in other sectors are costs incurred in non-health care organisations but which have an impact on the health provision of individuals. These include for example, research, training, education activities carried out by other sectors which may prevent illness or the reduction in cost of alcohol leading to increase in illness. The wider social costs, such as the costs of food, shelter and administration, provided by other non-health service organisations are included in this category.

These costs in aggregate are called the "cost of illness" in society (Drummond et al., 2005), in other words the spillover of benefits and disbenefits of healthcare provision is reflected in such estimation. Mugford (1996) highlights that economic evaluation methods, in estimating the organisational costs of a health service, do not adequately deal with the impacts of organisational constraints such as capacity. This is a consequence of such methods measuring the use of resources from a static position rather than a dynamic one as used by management accountants. A joint economics accountancy method for estimation may accommodate the cost impact of growth or capacity changes in the organisation.

In the context of health service research Buxton and Hanney (1996), Buxton et al. (2000) and HERG et al. (2008), highlighted the need to measure benefits generated from research in health services. They categorised such benefits in terms of improved capacity, skills and knowledge base for organisations undertaking research (Buxton and Hanney, 1996; Buxton et al., 2000; HERG et al., 2008). In their categorisation the benefits spillover in the shape of improved research capacity, potential cost reduction in the health care sector, and the broader political, economic and administrative benefits are included (Buxton and Hanney, 1996; Buxton et al., 2000).

As discussed by Ghosh (2003) and economists (Chapter 2, 2.4), medical knowledge may be measured as a “private good” when market valuations for such knowledge is protected through patent laws, or physically excluded by being incorporated into a specific product, for example pharmaceuticals. In addition, Woodward and Smith (2003) and Ghosh (2003) highlight that the access to benefits from medical and health knowledge can often be excluded by the lack of health systems and tangible infrastructure in other words the "structural capital" dimension of "knowledge capital" (Chapter 2, 2.3). The measurement of spillover benefits is thus challenging in a situation where market valuations are not always possible.

Economists' methods, such as cost-benefit analysis, cost-utility analysis, cost-effectiveness analysis and cost-minimisation provide frameworks for measuring and comparing the wider costs and benefits of health care interventions to the economy mainly from a societal perspective. The estimated costs of health services are based on where the cost is incurred, such as in health service organisations, by patients and in other sectors. However, the impact of capacity constraints in health service organisations is not reflected in cost estimations used in economic evaluation methods. In this connection, the National Institute of Clinical Excellence (NICE) (2008) recommends that organisations undertake cost impact analysis built on accounting principles rather than just health economics principles in the implementation of NICE clinical guidelines. When a cost-minimisation study adopting a patient, provider or purchaser perspective is undertaken, the risk of shifting cost to others is not taken into account.

The perspective adopted and the purpose of the study determines whose cost and what type of costs are included. Whilst economic evaluation methods do attempt to measure outputs in terms of health outcomes or utility scores of the individual receiving care, they do not explicitly measure the spillover of benefits from organisations to the health service sector and the economy. Such spillover benefits take the shape of new health and medical knowledge, increased health service capacity, clinical skills, health information and generation of research skills as discussed earlier in section 3.3. Benefits that spillover into society in general from health services and knowledge generation by organisations forms the "public goods in health" that is non-rival and non-excludable in part in certain circumstances. Whilst economic evaluations in health service are based on welfare to society, such spillover benefits are not fully recognised in the management of health systems. A reason for such omission could be the challenges posed in its measurement.

3.4.3 Economists' and Accountants' views of costs

Economic evaluation in health service is mainly based on the impact of such services on the total welfare of society. In adopting the societal perspective economists, therefore, recognise the additional resources utilised from outside the health service organisation in providing health services to an individual (McPake et al., 2002; Drummond et al., 2005). Such additional resources are often provided by patients, family members and charitable organisations. Likewise, the benefits from the provision of health services, from a societal perspective, extend out to patients, the organisations providing care, their staff and society.

Management accountants, however, adopt a particular organisation's perspective to measure the costs of service provision based on historical outlay of funds. Their aim is to support resource allocation decisions of that organisation. Costs in the organisational context are categorised as direct, indirect and overhead costs (Chapter 2, 2.5). Economists on the other hand for purposes of informing health policy, can take a wider perspective. Using the "opportunity cost" principle they estimate the cost of resources and the benefits to society from productive individuals in monetary and non-monetary terms. In measuring resources management accountants and health economists, nevertheless, use the concepts of direct cost, indirect cost and intangible costs differently as listed in Table 3.1.

Table 3.1 – Definitions of costs

Costs	**Economic Evaluation: mainly from societal perspective**	**Management Accountancy: purely organisational perspective**
Cost	Cost of an opportunity forgone by choosing an intervention versus an alternative intervention is "opportunity cost" (Drummond et al., 2005, pg 24)	Cost of material, labour, other resources used to produce a service and incurred by the organisation (Chapter 2, 2.5).
Direct Costs	Costs incurred in the health sector, sometimes also includes out of pocket expenses of the patient (Drummond et al., 2005, pg 24)	Costs of resources incurred by an organisation that can be identified directly as core to the production of the health service (Chapter 2, 2.5).
Indirect Costs	Costs incurred or benefits forgone by patients using the service such as the cost of working time lost (Drummond et al., 2005, pg 24)	Costs of resources incurred by an organisation which are subsidiary to the health treatment, e.g. cost of meals. "Overheads" are costs that are shared and not directly attributable to the service delivery process examples rent, rates (Chapter 2, 2.5)
Intangible Cost	Consequences, which are difficult to measure such as improved health. (Drummond et al., 2005, pg 24)	Intangibles as non-monetary resources without physical substance from which future benefits are expected (Chapter 2, 2.5)

Management accountancy principles govern the use of the cost terms from an organisational perspective, whereas economic evaluation can be based on a wider perspective to maximise benefits to society. The method used for attributing monetary value or cost to the resources used for service provision therefore depends on the purpose and perspective of the evaluation.

Both disciplines calculate the total cost of service delivery in an organisation based on the cost of inputs. Initially the resources used solely to deliver service to a particular group of patients are identified then multiplied by the unit cost of the resource. The resources include specialist clinicians' time, nursing time and resources that are often shared between different health services and different groups of patients, for example, ward beds etc.

The range of costs included is restricted to organisational cost in the management perspective while economic evaluation can include cost incurred in both monetary and non-monetary terms, from a societal perspective. The National Institute of Clinical Excellence (NICE, 2008) guidelines recommend that cost impact analysis be built on accounting principles rather than purely health economics principles. Earlier, Mugford (1996) and Drummond et al. (2005) have argued along similar lines for a joint accountancy economics approach when estimating costs of resources used for health service interventions and programmes in economic evaluation exercises.

Management accountancy methods used for costing health service, based on resource inputs identified by those delivering the service, can therefore to an extent help estimation, allocation and costing of resources used for service delivery and knowledge creation. Such methods of costing resources serve both organisational management needs and some aspects of economic evaluation as recognised by economists (Drummond et al., 2005; Mogyorosy and Smith, 2005; NICE 2008). Measurements in economic evaluation help highlight the spillover of benefits from health service provision outside of the organisation in monetary and non-monetary terms. The disbenefits that may arise because of ineffective or inefficient health service delivery are however, not directly measured by economic evaluation exercises. Neither do accountants make a systematic estimation of potential costs to the organisation based on risks identified through the organisation's risk strategy.

3.4.4 Measurement of outputs: Dimensions of "knowledge capital"

At the macroeconomic level, the MERITUM projects guidelines (2002), management accountancy guidelines (CIMA, 2001) and other previous studies, identify the intangible outputs produced by organisations in the course of producing goods and services (Chapter 2, 2.5). The measurement of "knowledge capital" in health requires the identification and measurement of the internally generated knowledge based outputs including the "public goods" aspects. The spillover and open access to such benefits are necessary for safe and effective health service provision (section 3.3). The identification of "knowledge capital" in health therefore needs to build on OECD (1998) categorisations to include health related benefits that spillover into the health economy, and measurement methods based on input pricing approaches used in the valuation of other assets.

Austrian Research Centres-Seiborf whose main outputs are research, adapted the MERITUM project guidelines (Chapter 2, 2.5), to publish a report on "knowledge capital" using managerial and accounting data (Leitner and Warden, 2004). The research centres used the inputs of their production activities to measure and report on "knowledge capital" in monetary terms (Leitner and Warden, 2004). In their report, the research centres used staff turnover statistics and the number of days invested in training staff to categorise and measure “human capital”. The “structural capital” category included the IT expenses per employee, non-monetary data such as success ratio for EU programmes and the numbers of databases for which the organisation had rights of access (Koch et al., 2000). Similarly, the “relational capital” aspect was reported by listing research activities outside the home country. This is in terms of man years, EU projects as a percentage of all new projects per research worker, the numbers of conferences attended, lectures at scientific conferences, teaching assignments, referees on journals and evaluation panels and the number of times the organisation name was mentioned in relevant media (Koch et al., 2000).

Much of the data used in the “knowledge capital” reporting was routinely used for management decisions within the research centres, similar to data generated and used in health services organisations. Leitner and Warden (2004) found a benefit linked to the interaction between the self funded research projects and commercially commissioned research projects in the Austrian research centres. Examples of such spillover benefits took the shape of additional skills development and new process knowledge in the organisation and the sector (Leitner and Warden, 2004). These spillovers are seen as an important additional intangible output by the organisation, but not categorised separately.

Habersam and Piber (2003), in their empirical study of two hospitals, extended the MERITUM (2002) taxonomy of human, structural and relational capital to include “connectivity capital” as the linking pin or the glue for the other aspects identified in MERITUM projects. They argue that the hospitals create the “connectivity capital”, that is a social, organisational and physical frame to enable interaction between professional groups with different competencies (Habersam and Piber, 2003). They see that representation of "knowledge capital" through narratives, financial and non-financial metrics with the connections between the components highlighted can be more meaningful than lists of financial and non-financial metrics, for decision making in health service provision.

As highlighted in chapter 2, 2.5, the MERITUM projects and previous studies defined "knowledge capital" as the knowledge based resources that contribute to innovation and growth. The taxonomy proposed for "knowledge capital" in these studies is "human capital", "structural capital" and "relational capital" encompassing the human aspects, the processes, technological aspects and the relationship aspects of "knowledge capital". In the health service context this approach may help as a starting point for measuring the outputs of an organisation to include estimates of the benefits generated by service provision that spillover into the health system and wider society. In effect, the economists' societal perspective is also then reflected by the organisations, to the extent where the benefits overlap. However, the categories identified so far do not explore or accommodate the "public goods" aspects or the additional service provision capacity that is created by the spillover of improved skills, processes and health knowledge into the wider health system.

"Knowledge capital", when applied in the management of health services can be categorised as "human capital", "tangible capital", "relational capital", "public goods in health" and "capacity in health". In health service, "structural capital" could take the shape of "tangible capital" and the more intangible aspects that spread to health systems as "capacity in health". "Human capital" includes human based competencies such as training and "tangible capital" includes tangible assets, databases and so on. "Relational capital" is related to clinical and research reputation generated with clinical and non-clinical colleagues and external stakeholders that generates funds from commercial sources. "Public goods in health" as a category may help explore the benefits created through interaction with patients, such as health knowledge, processes for creating expert patients, patient networks, patient satisfaction, support groups, and caring externalities. Organisational routines, processes, guidelines, skill transfer and development that spillover and increase the capacity for health service provision within the health system are called "capacity in health". The latter two categories, though not containable by the organisation can have an impact on the reputation of the team and organisation.

3.5 Summary of findings

In summary, health is a knowledge based service that is delivered using the tacit and explicit knowledge of clinical and non-clinical staff some of which is acquired through service provision (Clarke and Wilcockson, 2002; Sandars, 2004; Nicolini et al., 2008). Staff providing health services exhibit a preference for knowledge generated in local practice and to access such knowledge through social processes (Clarke and Wilcockson, 2002; Currie et al., 2008). Nevertheless, there is limited evidence that providing clinical guidelines for clinicians in electronic form have an impact on care provided (Stefannelli 2001). The sharing of knowledge on good practice in healthcare is critical for the delivery of safe health services (DH, 2002a; Newell et al., 2003; Currie et al., 2008).

Economists recognise that health knowledge and other benefits generated in health services extend more widely than to the purchaser of the services (Buxton and Hanney, 1996;

Buxton et al., 2000; McPake et al., 2002). Their work, however, addresses the benefits or "payback" from research or explicit knowledge creation but not the knowledge based resources created in the course of routine service provision (Buxton and Hanney, 1996; Buxton et al., 2000). The recommendation of McGillis-Hall (2003) and Covell (2008) is relevant for recognising aspects of "knowledge capital". They recommend that the contributions of clinical staff knowledge and skills and investments in the development of such knowledge based resources be included in measuring productivity of nursing resources. Such contributions would thus be included in the ratio of cost of input and revenues from output. Under certain circumstances health services and knowledge resources generated exhibit features of “public goods”, that is the benefits from such resources cannot be fully excluded and consumption does not reduce the benefits for the next consumer. These “public goods” features exhibited by health services and knowledge add further challenges to the measurement of "knowledge capital" in health and so not addressed in previous studies.

Accountants and economists can adopt differing perspectives in measuring the resources used for health service delivery and the benefits derived from such services. Management accountants take an organisational perspective (section 3.4.1) in assessing decisions and reporting on resources in organisations by measuring resources used for service delivery and outputs mainly in monetary terms. On the other hand, health economists can adopt a societal perspective in economic evaluation of health service costs to assess impact on the total welfare of society by measuring costs and benefits that extend beyond the organisation (section 3.4.2). Economic evaluation methods however measure resource uses from a static position hence do not adequately deal with the impacts of organisational change on the costs of a health service. Additionally, definitions of the different types of costs and the terms used by the two disciplines vary (section 3.4.3).

The disciplines, nevertheless, converge in that both accountancy and economic methods are informed by the “opportunity cost” principles in the estimation of cost of investments. A joint accountancy economics approach incorporating accounting principles (Mugford 1996; Drummond et al., 2005; NICE 2008), as recommended, therefore may be a feasible option to estimate costs of resource use in joint production of "knowledge capital" in health services. Such a joint approach for measuring the cost of resources could potentially accommodate the impact of growth or capacity change in an organisation. Furthermore, such estimations of cost of resource use in health service interventions could be used as the organisational cost element in economic evaluation exercises and analysis of institutional efficiency.

A number of studies define these knowledge based resources as “knowledge capital” using the classification of “human capital”, “tangible capital”, “structural capital” and “relational capital”(MERITUM, 2002; CIMA, 2001; Leitner and Warden, 2004). “Connectivity capital”, which brings together the different aspects of such resources in the provision of services (Habersam and Piber, 2003), is a further classification used to describe the resources health service organisations provide. An Austrian research institution has produced “knowledge capital” reports, using the MERITUM guidelines as a base for adapting internal management reports and external stakeholder reports (Leitner and Warden, 2004). Similar to organisations involved in the MERITUM projects it found the process of developing “knowledge capital” reports provided insights into activities that generate knowledge which add value to the organisation, the wider economy and society

(Mouritsen et al., 2004; Leitner and Warden, 2004). The resources routinely generated by health organisations that spillover into the wider health system as "public goods" and increasing capacity within health systems however are not yet categorised.

In the health system in the UK, organisations are accountable for performance and management of tangible inputs and outputs of health service delivery. Additionally, certain aspects of "knowledge capital" are required to be reported separately and distinctly through care quality reports, R&D reports and charitable funds reporting, discussed further in chapter 6, 6.2.7. Although there is limited recognition in NHS policies of the interdependency of service delivery and knowledge creation (Follett and Paulson-Ellis, 2001) the knowledge based outputs that are generated and used are not explicitly measured and accounted for as a joint and interdependent output. The outputs of health service are measured in monetary terms as revenue while waiting times and numbers of complaints are used as proxy for quality measures.

The NHS policies for funding and managing service delivery are separated from the policies for funding and management of research and capacity development in the NHS. There is, however, limited recognition within these policies of the resource impact of learning and knowledge creation while delivering specialist health service and research (DOH 1998, 2007a). The NHS performance management framework mainly focuses on the performance of health service delivery, even in the case of hospitals delivering specialised services (Chapter 6, 6.2.4). The risk to quality of patient care raised by the separation of health service provision and knowledge creation is highlighted (Clarke and Wilcockson, 2002; Currie and Suhomlinova, 2006; Nicolini et al., 2008). Nevertheless, the generation of knowledge or development of capacity through service provision does not form an integral part of performance management of health services but is managed separately as distinct parts.

There is some recognition in literature of the contribution made by health service delivery towards development of human capital and the capacity for health research (McGillis-Hall, 2003; DH, 2006b). The economic benefit of research in health services is recognised (DH, 2005b, 2006b) and measurement of spillover is explored mainly in the context of medical research and R&D (Buxton et al., 2000; HERG et al., 2008), but knowledge resources routinely generated in course of service delivery are not included. The identification and measurement of the knowledge based resources, skills and capacity, and health service developments that organisations generate with service provision are limited (McGillis-Hall, 2003). "Knowledge capital" as a composite resource co-created with service provision is not well recognised or measured by organisations or health systems.

3.6 Conclusions: Concept of "knowledge capital" in health services

In conclusion, the concept of knowledge capital is central to effective health service provision, generating benefits that extend beyond the organisation delivering the service. The resources required for the provision of health service include tangibles and intangibles in the form of intellect, knowledge, know-how, skill and intuition that is locally accessible. The term “knowledge capital”, rather than "intellectual capital", encapsulates the intellectual, rule based or technical knowledge and the more fluid experience based knowledge required in the healthcare context.

The sharing of tacit and explicit knowledge is central and critical for the safety and effectiveness of health service provision as practitioners prefer to access locally generated knowledge within a social process (Clarke and Wilcockson, 2002; Sandars, 2004; Gabbay and Le May, 2004; Nicolini et al., 2008). However, the National Knowledge Service (2005) appears to focus on databases and electronic access to knowledge, which does not appear to consider such preferences into account. This raises some challenges for the effectiveness of electronic modes of knowledge transfer in health service practice.

Health service organisations provide a shared context for the generation, transfer and interaction of knowledge to form the various components of “knowledge capital” including "public goods in health" produced through service delivery (Buxton et al., 2000; McPake et al., 2002; Habersam and Piber, 2003). In this regard, Nonaka and Takeuchi's (1995) SECI model (Chapter 2, 2.3, section 3.3), is suitable for the study of the dynamic transfer of tacit and explicit knowledge in the shared context of service provision. The examination of the health service delivery processes through this model could thus further the understanding of the role and nature of “knowledge capital” generation in health service. Such understanding provides a start for the identification of this difficult to define resource in health, to the extent possible, using an organisational management perspective.

In terms of measurement of outputs of health services, market prices are not a good proxy for "opportunity cost" as there are third party payments, government interventions for these services, which are not fully traded and in certain circumstances are "public goods". Organisations, using financial accounting guidelines, face challenges in reporting the value of knowledge based resources generated through health service delivery, such as health knowledge (Buxton et al., 2000), public health data (Black, 2003), fund raising by patients and public (McPake et al., 2002) and development of capacity within a health system. Economic evaluation of health services although sometimes adopts a societal perspective to measure costs and benefits of health interventions including costs and benefits of other organisations and consumers. Nevertheless, benefits that spillover into the health system and economy, such as knowledge creation, capacity generation and skills development are not yet included in the economic evaluation exercises.

From a health system perspective, some of such benefits generated, such as knowledge on infectious disease, can impact health across international borders and are therefore classified as “global public goods” in terms of global trade. This is to make global access to benefits from such goods free. The “public goods” features of knowledge based resources in health add to the challenges for the measurement of such resources and benefits from them to the organisation and health system. Attempts to measure and manage such resources are necessary as such resources are significant for the growth and development of the health system and the economy as a whole.

Accountants and economists attempt to address such challenges of measurement in evaluating health services using accounting costs as practical estimates of "opportunity cost" (Drummond et al., 2005; Mogyorosy and Smith, 2005; NICE 2008). Accountants build on "opportunity costs" in using management accountancy principles to measure and estimate the monetary value of resources used and outputs produced in support of resource allocation decisions. Management accountancy tradition defines costs as direct, indirect and overhead, based on their relation to the production process within the organisation.

Any shared costs are thereby attributed based on the service provider's judgement on resource use.

A joint accountancy economic approach is suggested for estimating the cost of resources used for health service provision (Drummond et al., 2005; Mogyorosy and Smith, 2005; NICE, 2008). Such an approach could accommodate the reflection of organisational capacity issues, short and long run cost and benefits that spillover into health systems and the wider society. A management accountancy method adapted with economic evaluation approaches, therefore, may provide a mechanism for the measurement of this difficult to measure resource. This method, as a start, involves the estimation and attribution of the cost of joint resources used by organisations for service provision and categorisation of "knowledge capital" co-created with health services.

The uniform standards of reporting by health service organisations in the UK, together with external reports produced under statutory requirements can potentially be adapted to support a study on the definition and measurement of “knowledge capital” based on an internal perspective of the organisation (Chapter 2, 2.7). Currently outputs of health service provision, knowledge generation and skills development, are performance managed and accounted for as separate streams in monetary and non-monetary terms (DH 2005b, 2006b, HERG et al., 2008). There is therefore some recognition of the economic benefits from such knowledge resources. “Knowledge capital”, as a framework (Edvinsson and Sullivan, 1996; Sveiby, 1997; CIMA, 2001; MERITUM, 2002), could bring to the fore the interdependency of knowledge based resources generated for safe and effective health service provision providing a start for its recognition and measurement. Furthermore, this would support a stock take of "knowledge capital" embedded within the health system.

Chapter 4 Adaptation of conceptual models for measuring “knowledge capital” in health services

4.1. Introduction

This chapter develops two models from the literature reviewed in chapters 1 and 2 for the empirical study of the concept of “knowledge capital” in health service. The first conceptual model, the “knowledge creation cycle”, is an adaptation of Nonaka and Takeuchi’s (1995) modes of knowledge creation, namely “Socialisation, Externalisation, Combination and Internalisation”, the SECI model (Chapter 2, 2.5). The purpose of the “knowledge creation cycle” model is to help study the transfer of tacit and explicit knowledge between individuals and groups and the creation and capture of such knowledge through the process of health service provision. The second model “dimensions of knowledge capital in health”, builds on the classification of “knowledge capital”, provided by CIMA (2001) and the MERITUM projects (2002) to categorise the “public goods” aspect of an increased knowledge base and capacity for knowledge generation co-created in health service.

Traditional accounting methods face difficulties in measuring this resource partly due to the absence of market value in the conventional sense. An input pricing approach to valuation therefore becomes the feasible choice. Understanding the processes of service delivery and knowledge creation from the organisation’s perspective using the “knowledge creation cycle” as a framework, could help identify processes, the tangible and intangible inputs and outputs of the joint production of health service delivery and knowledge creation (Chapter 3, 3.6). Management accountancy principles, as discussed in chapter 2, 2.6 and chapter 3, 3.4, maybe useful for estimations and allocation of the costs of inputs of the joint production of knowledge based resources in health service. Such estimates could form a basis for defining and measuring "knowledge capital" in health.

Organisations routinely collect data for external and internal reporting of their financial position using defined guidelines. This data collected for internal management purposes such as budgeting and costing lends itself to further analysis. An additional focus for the enumeration of each resource used for a health intervention, or in NHS terminology, “bottom up” costing (DH, 2005a), requires the allocation of the resources used for that specific service. The estimation of the cost of resources is made using activity based costing principles (Chapter 2, 2.5). In addition, for estimations of cost of service delivered, the service providers’ engagement is necessary in the identification and quantification of resources used (McPake et al., 2002; DH, 2005a, 2007c, 2008a). During the time of the study, disaggregation of costs to service level is beginning to be required of organisations in the NHS in the UK (DH 2005a, 2007c, 2008a). Management accountancy methods may thus provide the structure for engaging practitioners in the codification and abstraction of data that may help identify and estimate a money value of “knowledge capital” generated in health service (Chapter 3, 3.4.1, 3.5).

This thesis, therefore, takes the organisational management perspective as the most feasible and appropriate in attempting to measure all outputs of health service provision. This is so as the context of creation that determines the metrics and values of knowledge based outputs (Winter, 1987; Sveiby, 1997; Teece, 2000; Andriessen, 2004). Using management accountancy techniques, informed by economics and accountancy approaches (Chapter 3, 3.5), the estimation of the costs of inputs and outputs could produce a practical tool that is useful for practitioners in managing health services. In doing so this further provides a meaningful framework to engage providers and makes feasible the estimation and allocation of the costs of inputs and joint outputs of health service provision within its context. Any potential organisational constraints for the delivery of the service can be accommodated in such cost estimations. Estimates of the organisational cost of services developed in this manner may then be useful for estimating such costs in any economic evaluation of health services.

The second model, “dimensions of knowledge capital in health”, builds on the dimensions proposed by CIMA (2001) and the MERITUM projects (2002). This categorises the full spectrum of benefits from clinical service to knowledge based resources generated, including the “public goods” aspects, which accrue in the course of health service provision. The nature of “knowledge capital” is such that measurement of this resource requires both monetary and non-monetary metrics and its value determined by its use. The reports and data that organisations currently use for internal performance management and external reporting can be a useful source of data for this purpose (Leitner and Warden, 2004). Organisations could thus build on methods used for reporting economic performance to measure and report “knowledge capital” in health.

4.2. Use of the theory of knowledge creating organisations

In the context of understanding the dynamics of knowledge creation that occurs in organisations, Nonaka and Takeuchi’s (1995) theory of knowledge creating organisations and the knowledge spiral (chapter 2, 2.3) are widely cited in management literature. Organisations play a part in managing the working environments where organisational knowledge creation can expand into communities of interaction that go across sectional, departmental, divisional and organisational boundaries (Umemoto, 2002). The SECI model has been successfully used (Umemoto, 2002; Chapter 2, 2.5) to observe how organisations created knowledge, utilised existing knowledge and embedded group and individual knowledge into explicit systems within the organisations.

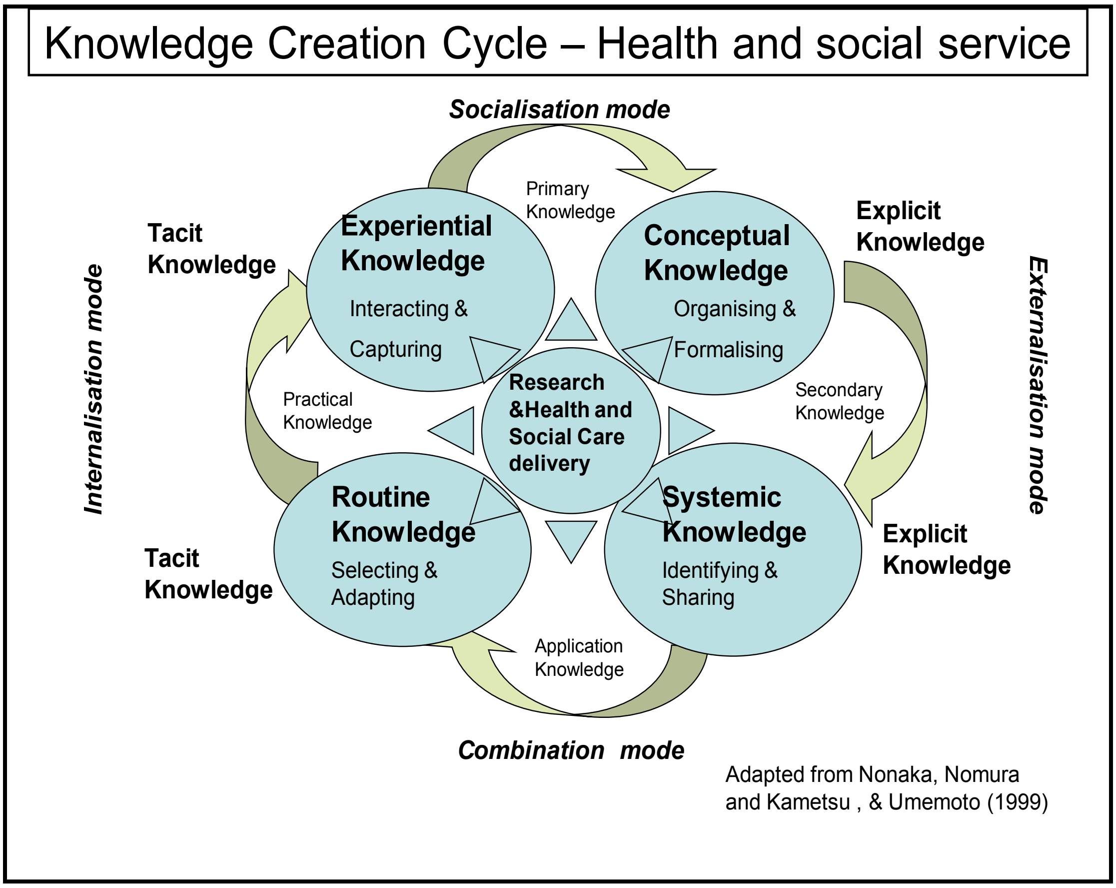
The SECI model sees the transfer between tacit and explicit knowledge in a shared context of producing goods and services as the core of knowledge creation in organisations. This model, therefore, may be adapted to study and understand the process and resources used for health service delivery (Chapter 3, 3.6), a knowledge intensive service (Good, 2001). This is a service where practitioners exhibit a preference for using "proximal knowledge" or context specific knowledge together with evidence and policy in delivering care to patients (Clarke and Wilcockson, 2002; Newell et al., 2003; Currie et al., 2008; Nicolini et al., 2008; Chapter 3, 3.3). The model "knowledge creation cycle in health" (Figure 4.1), building on the SECI model, is thus proposed as a framework for the study of tacit and explicit knowledge transfer between patients, practitioners and organisations. The resources and values created within the context of health service identified, to the extent possible.

4.3. "Knowledge creation cycle in health"

Applying the SECI framework the joint process of health service delivery and knowledge creation can be seen as a knowledge creation cycle (Figure 4.1). A clinical contact is seen as an encounter where experience is interpreted through medical knowledge, conflict resolved through dialogue, which sometimes leads to transformation of those involved

(Good, 2001). Within this framework, therefore the service delivery process is considered as interactions between clinicians and patients with experiences and knowledge on health issues (Figure 4.1). In this setting clinical language is used as a medium for the translation of knowledge from patient experience into clinical and management data. Health service provision, therefore, is seen as being delivered through the sharing of knowledge. Such sharing uses processes and routines established in the organisation thereby generating a knowledge creation cycle as in figure 4.1.

Figure 4.1 – Knowledge Creation Cycle



The modes of knowledge creation in organisations proposed by the SECI cycle (Chapter 2, 2.5) are adapted in this thesis, as in figure 4.1, to aid understanding of the interdependency of tacit and explicit knowledge in the delivery of health services (Chapter 3, 3.3). The creation of knowledge both at the individual and group level, which is used to improve local health service delivery (Chapter 3, 3.3), can be explored. The first interaction, called the "Socialisation mode" captures as patient data, the patient's experience or "experiential knowledge" such as the current state of health in general and the specific problem experienced (Chapter 3, 3.5). This data, when organised and formalised, becomes information for those delivering health services in the "Externalisation mode". Concepts such as patient history, symptoms, co-morbidities, contacts and so on, using clinical knowledge or "conceptual knowledge" is used for such formalisation. Further organisation of this data, using other "conceptual knowledge" such as accountancy and management codifications, becomes management data as categorised by National Knowledge Services in the UK (www.NKS.nhs.uk, 2005, Chapter 3, 3.5).

The service delivery process in health creates the shared context for the various practitioners and individuals involved in the process. The process of delivering health service thus can facilitate the conversion of information into knowledge for the individuals involved. Some of the knowledge created is shared and embedded within the clinical group and organisation. A systemised way of sharing the knowledge between the immediate players and future users of this knowledge is identified in the "combination mode". This enables the combination of knowledge of clinical and administrative staff within the organisation and wider industry networks. The systemisation creates "systemic knowledge", such as guidelines and standards, within the organisation which often spillover into the health system, industry and professional networks. In the "internalisation mode" by selecting and adapting the experiential and conceptual knowledge into actionable routines, such as patient admission procedures, ward rounds, "routine knowledge" that is suitable for effective service delivery is created. Such "routine knowledge" is not only available to patient and practitioners but accessible for wider public consumption becoming a "public good in health" (Chapter 3, 3.6).

The SECI model (Chapter 2, 2.3) although used to study organisations from a knowledge creation perspective (Umemoto, 2002) in various sectors such as electronics manufacture and telecommunication has not been used in the study of how clinical knowledge is translated and adapted to individual patient need in health service provision. In health services the sharing of local tacit knowledge between a patient and staff happens as a social process for example in clinical consultations. This enables the service required to be made into a routine but one adapted to individual personal circumstances at the time of delivery. Tacit knowledge is identified as an aspect not often adequately addressed by knowledge management systems in the health service sector (Currie and Suhomlinova, 2006; Nicolini et al., 2008). The culture, knowledge investment and infrastructure for knowledge creation and the extent to which new knowledge generation converts to "knowledge capital", can be explored through the "knowledge creation cycle" model.

This model, therefore, could support the study of processes and identification of resources used for the capture and transfer of tacit knowledge into explicit and vice versa in the course of health service provision. Firstly, it is suited for the inclusion of the conversion of the patient's tacit knowledge into explicit through interaction with clinical staff. Secondly, it can provide a framework to investigate the processes by which patients' and staff knowledge is shared, captured and organised into concepts using professional knowledge and to identify resources required for service provision (Chapter 3, 3.6). It is therefore appropriate for understanding the context of knowledge creation and the utilisation of resources including existing knowledge in service delivery.

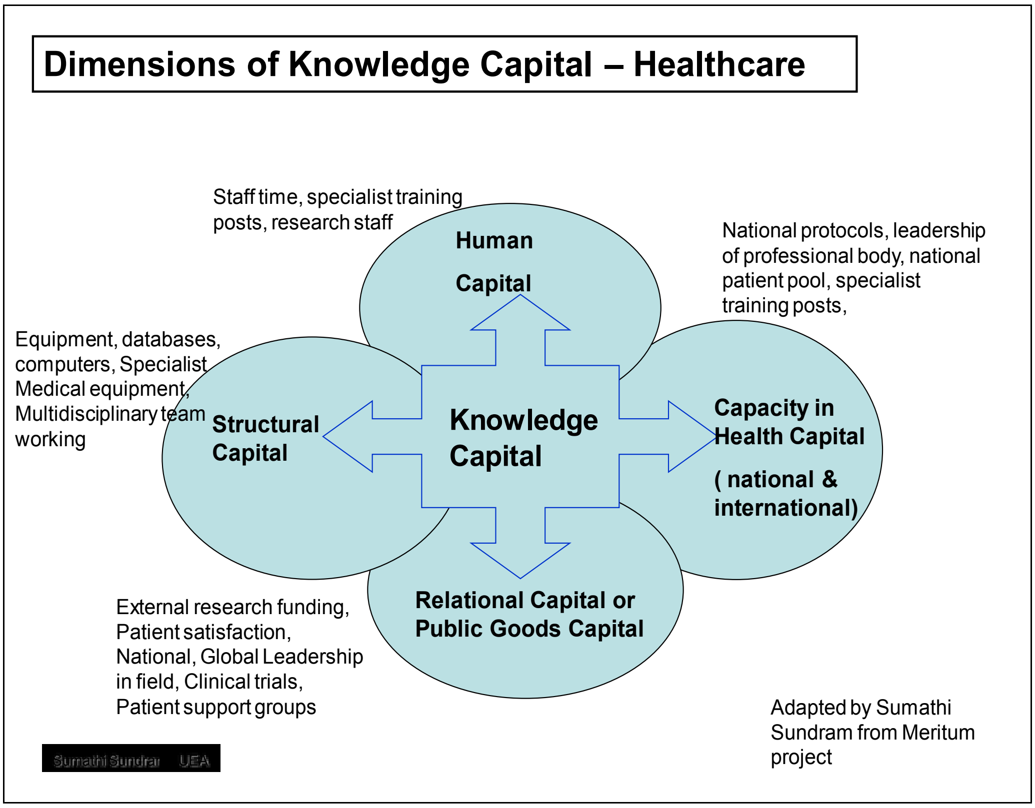
4.4. Costing inputs for health service delivery

Measuring "knowledge capital" becomes challenging in health service organisations as costs incurred on inputs are for joint outputs and often not separable (Chapter 3, 3.5). These goods do not appear in a conventional sense as having a market value nor can they be fully controlled by the organisation producing the service, therefore, raising further challenges for measurement and reporting by accountants (Chapter 2, 2.5.1). In light of this an economics approach of input pricing together with management accountancy techniques of "bottom up" costing, may be a feasible approach for organisations to identify and develop mechanisms to recognise and measure components of "knowledge capital" co-created in health service provision (Chapter 3, 3.6).

4.5. Dimensions of "knowledge capital" in health

The difficulties of defining and measuring "knowledge capital" as a resource are recognised at an organisational and macro-economic level (Chapter 2, 2.5). At a macroeconomic level the OECD commissioned EU funded projects from universities across Europe collectively called the MERITUM projects, to develop guidelines for reporting such intangible resources (OECD, 1999; DATI, 2000; MERITUM, 2002). In agreement with these, various studies and management accountancy guidelines also recommend human, relational, and structural capital as categories for "knowledge/intellectual capital" (CIMA, 2001, Chapter 2,2.5). These categories for "knowledge capital" adopted in previous studies and management accountancy guidelines are adapted for health service as shown in figure 4.2.

Figure 4.2 Dimensions of knowledge capital in health



In figure 4.2 "Human capital" is defined, as in earlier studies and guidelines (CIMA, 2001), as knowledge, skills and experience that employees take with them when they leave, some of which are unique to the individual and others more generic. "Relational capital" is defined as the value linked to the relationships external to the organization, such as professional bodies, other researchers and other providers in the clinical network. "Relational capital" in health services is linked mainly to the research and technical reputation built both with commercial and with-profit organisations. The "public goods in health" is a dimension which includes reputation built associated with processes for developing health skills, information, knowledge and health services and such resources that are non-excludable. "Structural capital" is defined as the knowledge that stays in the organization such as the tangible assets and includes raw material access, routines, procedures, systems, cultures, databases, etc. "Capacity in health" is a dimension reflecting the increased capacity and skills generated that spills over into health systems and society, similar to "public goods in health". The nature of these resources is such that the categories overlap posing further challenges for measurement.

Previous studies in service industries such as research, defence and healthcare products (Koch et al., 2000; MERITUM, 2002; Habersam and Piber, 2003; Leitner and Warden, 2004; Chapter 3, 3.5), categorise "knowledge capital" as human resources, relational and structural. In delivering public services, including health services, there are additional unintended outputs produced in the shape of increased health knowledge and goodwill of patients and other users (Buxton et al., 2000; McPake et al., 2002). The "public goods" aspects generated by public services and the increased "capacity in health" for the system, however, are not separately categorised in any of these studies (Chapter 2, 2.6).

In this model "dimensions of knowledge capital" (Figure 4.2), the longer term benefits from health service provision that accrue to the organisation as a result of the spillover into the wider economy are included in the category of "public goods in health capital". These could include increased health knowledge in practitioners and patients, information and intelligence that is more robust for public health policies and research and the social acknowledgement of the value of the benefits of the health service received by users of the service (Chapter 3, 3.4). "Capacity in health capital" is about enhanced skills and know-how in the shape of shared guidelines, protocol and best practice (Chapter 3, 3.4). The capability of national and international health systems to provide, develop and maintain the capacity for health service provision is thereby increased.

As part of statutory requirement of the public sector, NHS organisations (DH 1991, 1997, 1999, 2005c, 2006a, 2008b), report on many aspects of the "dimensions of knowledge capital" (Figure 4.2), discussed further in chapter 5. Data routinely collected and reported by NHS organisations to the regulatory bodies in their annual reports on health service, research and quality therefore could support health organisations in categorising the "knowledge capital" generated (Wall, 2005; Chapter 3, 3.5).

NHS organisations report tangible assets through the capital assets register as part of the public capital financial reporting requirements. Human resources and finance functions of the organisations report regularly on the workforce diversity, performance and contracting to the NHS. Some aspects of "capacity in health capital", such as increased capacity to develop new health interventions or research, are reported nationally through reports on performance of research, teaching and training activities. Specialist hospitals report on the level of specialist services provided as part of reporting on contract performance to the National Specialist Services Advisory Group (NSCAG).

The R&D and financial reporting regimes within the NHS include details of national protocols that emerge from research undertaken and the external funding attracted by the hospital teams. Funds generated by health service organisations from charitable donations and research grants is also accounted and reported separately as charities within the organisations, under the Charitable Trusts regulatory regime. This reporting responsibility and framework for the organisation is separate and distinct from delivering health services. This is because these charities are seen as separate entities, though anchored in the NHS organisation. The reporting requirements for both regimes are further detailed in chapter 5.

It can thus be argued that some aspects of "knowledge capital", such as "human capital", "public goods in health" and "tangible capital", although not recognised as components of “knowledge capital”, are reported in the NHS under different aspects of multiple regulatory requirements (Wall, 2005). The concept of “knowledge capital” may thus act to integrate the performance management of clinical service provision and knowledge generation. Furthermore, it can highlight the important interdependency of health service delivery and the capture and use of knowledge generated in the course of service provision.

4.6. Summary

Summarising, the model “knowledge creation cycle” in health is proposed as a starting point for using practitioner insights to study and understand the context and resources used in the joint production of health services and "knowledge capital". It provides a framework to understand the transfer of a spectrum of knowledge in service provision and to engage practitioners in the identification and enumeration of tangible and intangible knowledge based resources (DH, 2005a, 2007c, 2008a). This model thereby can help to understand and synthesise management perspective on use and capture of knowledge based resources generated in health service production.

For measurement, economists and accountants use the cost of inputs as the basic premise for recognising and valuing an asset in an organisation (Chapter 2, 2.7). This approach provides a feasible starting point for measuring intangible outputs. The resources used in service provision can then be identified, disaggregated, allocated between co-created outputs, and costed using management accountancy methods based on provider insights. The costing methods used within the health service organisation become the natural choice for costing the inputs of joint production and the revenues of service delivery (Chapter 3, 3.6). This is particularly so as such costing methods also align with the “bottom up” costing recommended in the NHS (DH, 2005a, 2007c, 2008a).

The model "dimensions of knowledge capital" (section 4.5), developed from previous guidelines (DATI, 2000, 2003; MERITUM, 2002), could support the categorisation and measurement of the intangible outputs of health service, including "public goods in health" and "capacity in health". The additional categories accommodate some of the non-excludable benefits that spillover into society in the co-creation of health service provision and knowledge based resources. The "dimensions of “knowledge capital” is therefore put forward as a mechanism for organisations to identify and develop monetary and non-monetary metrics that support the measurement and management of “knowledge capital” in health.

4.7. **Questions raised**

There are hierarchies of research questions raised by the literature review for the management of “knowledge capital”, particularly resource allocation decisions, that need to be addressed from an organisational perspective, such as:

A. What factors should be considered in managing and funding the creation of knowledge capital?

i. What is knowledge capital in the healthcare setting?

ii. How is it created in the health service?

iii. What are its constituent parts?

B. What are the costs and benefits of creating knowledge capital?

i. What are the costs of the investment, and to whom?

ii. What are the benefits from the investment (capital formed), and to whom?

C. What should be supported and by whom?

i. Who pays for the knowledge creation?

ii. Who pays for the consolidation into capital?

iii. Who pays for the maintenance and use?

The above hierarchy of questions can be addressed from a number of perspectives and disciplines including legal, political, psychological, sociological and educational. This thesis takes an organisational management perspective and focuses on answers to the broad questions A and B above using the subsection questions for this purpose.

This thesis explores possible answers to these questions through an empirical study using the models derived from the literature reviews (Chapter 2 & 3) undertaken. The models are used as a framework for gathering and analysing the views from the operational and strategic perspectives of an organisation, including data routinely collected for internal reports. Such analysis could provide answers to the questions examined.

In Section I of this thesis, models are developed to aid the study of the context in which "knowledge capital" is created, used, and measured in terms of its dimensions in health service. A joint economic management accountancy approach is proposed for the measurement of the knowledge based outputs of health service provision. The models developed are tested as frameworks in an empirical study for the recognition of "knowledge capital" in health and the development of metrics for its measurement and management.

4.8. Implications for the case study.

The processes of service delivery and knowledge creation are not distinctly visible making the allocation of resources used and measurement of the joint products of health service and knowledge generation challenging. The study setting, therefore, needs to be in an organisation that delivers emergent health treatment. The full spectrum of activities will thereby include health service delivery, explicit knowledge creation or research, and development of skills and services. This organisation also needs to be engaged in generating explicit knowledge or health research that is paid for by commercial organisations. This could make the organisation's inputs and outputs of the joint production of health service and knowledge creation more visible and feasible for examination.

The resources utilised for service provision and knowledge based resources are so intertwined that the identification and allocation can only be feasible with practitioner understanding and engagement. In health service organisations in the NHS, the costing of health interventions at service level is still developing so cost data are not robust. The changes in the business environment of organisations could make practitioners anxious and so reluctant to engage in the study. Nevertheless, practitioner perspective is crucial in providing the context of use for addressing the challenges of identification and measurement of this resource.

Since "knowledge capital" is hard to define and to measure as a resource, any definitions and measures developed at an exploratory stage will be contestable. This study therefore attempts to establish if the likely scale of "knowledge capital" is large, and get some crude measure of scale. Furthermore, it tests out approaches to valuations that to varying extents get around the measurement and valuation problems and possibly identify potentially better strategies for measurement and valuation.

Section II: Use of "knowledge capital" models in an empirical study

Section II contains chapters 5, 6, 7 and 8 which describe the design, methods and choice of setting for the empirical testing of the models developed from the literature reviews in Section I. In doing so, Section II sets out to answer questions raised on the nature and measurement of "knowledge capital" as a resource in health services by using the models developed in chapter 4, 4.3, 4.5. Chapter 5 describes the background, rationale for design and choice of setting for the empirical study. Chapter 6 describes the background and methods used for the case study of pulmonary hypertension service provision at Papworth NHS hospital. Chapter 7 sets out the findings of this empirical case study.

Finally, in chapter 8, the findings from Section I and II are synthesised to draw out the implications for providers and policy makers in health services.

Chapter 5 Methodology and design of empirical study

5.1. Introduction

The aim of this chapter is to explore issues addressed in the choice of research design and methods for the exploring the concept of “knowledge capital” in the context of health. The models adapted and developed in chapter 4 through literature reviews are explored as frameworks of analysis. The issues addressed in choosing the unit of analysis and location of this study are discussed. The stages and methods used in this exploratory study of the nature, role and metrics for "knowledge capital" are detailed.

5.2. Methodology

This study attempted to understand the nature, define and measure “knowledge capital” in health as a resource. This was undertaken by examining the co-creation of health service and knowledge generation as perceived from a management perspective. Data generated for internal management and reporting to external regulators of the organisation therefore was used applying economics and management accounting principles. Such data was analysed using financial and management accountancy techniques. General issues in selecting research designs and methods for undertaking research in this topic are reviewed next.

5.2.1 Research Study Designs

Research study designs include surveys, experiments, history, archival analyses and case studies to meet exploratory, descriptive, evaluative or explanatory objectives. Descriptive and analytical surveys, archival analysis and experiment design are structured and favour quantitative data collection where findings are generalisable using statistical methods (Yin, 2005). Experiment design is undertaken when the investigator can manipulate events directly, precisely and systematically focusing on a couple of variables (Yin, 2005). Evaluative research, to assess how well a policy works, as Grbich (1999) suggests, uses information on processes and outcomes of policy such as quality of education, life years gained or health. Case study and history designs are, however, better suited to provide answers to the "how" and "why" questions related to the study of contemporary events over which investigators have no control (Yin, 2005).

These research designs often overlap and used in tandem to gain advantages from these different techniques, methods, concepts and language (Yin, 2005). Case study is particularly suitable for exploratory, descriptive and explanatory studies where contextual conditions are pertinent to the phenomenon studied (Yin, 2005; Ritchie, 2005), which survey and archival report analyses are not able to capture. Case study, as a research strategy, nevertheless, has the ability to deal with a variety of evidence such as documents, interviews and observations (Yin, 2005). This permits the generation of theoretical propositions that may be generalisable to other situations (Grbich, 1999). Generalisation of findings in case study design nevertheless requires the use of a previously developed theory as a template for the comparison of empirical results of the study (Yin, 2005).

A single case study is suitable for critically testing existing theory, to study either an extreme or a typical case, when investigating the first case of a kind and for longitudinal studies (Yin, 2005). There, however, exists the danger of the subject chosen turning out to be neither a typical nor an extreme case (Yin, 2005). Findings of multiple-case studies, however, can be more compelling as they provide either literal replication through similar results or a theoretical replication through contrasting results (Yin, 2005).

5.2.2 Research Methods

The use of both quantitative and qualitative techniques in a research study is defined as mixed methods research in education literature (Johnson and Onwuegbuzie, 2004). In social science literature a mixed methods approach is seen as an orientation towards social inquiry that invites participants into a dialogue about multiple ways of seeing, hearing and making sense of the social world (Greene, 2008). Such research uses a combination of qualitative and quantitative techniques, methods, approaches, concepts and language within a study drawing on the strengths and minimising the weaknesses of both (Johnson and Onwuegbuzie, 2004). Research design may have quantitative and qualitative phases or both approaches combined within and across the stages of the research process (Johnson and Onwuegbuzie, 2004). This approach is therefore appropriate for understanding the multifaceted and complex phenomena (Yin, 2005; Greene, 2008), such as "knowledge capital in health.

In health research context a mixed methods approach uses qualitative data to support the understanding of why a particular approach works or suggests ways of dealing with the issues. In this way, qualitative data contributes to understanding the processes shaping the implementation of a programme, while quantitative data can indicate the overall effectiveness of an approach or programme. In relation to research for policy making Mays et al. (2005) suggest that policy makers increasingly require evidence derived through a narrative synthesis, based on qualitative and quantitative research findings.

Qualitative data collected from observations and interviews on the other hand help investigate how things work (van Krogh et al., 1994; Yin, 2005). Such data provide insights into the context in which the resources are used for an utilisation-focused perspective in an explanatory study (Grbich, 1999). Additionally, use of multiple perspectives in multiple methods research help extend understanding gained from one setting to others (Ritchie, 2005).

In terms of measurement of resources, management accountancy reports generate quantitative data that can provide answers to what resources and how much of those resources are used in production (Drury, 2006). In health service organisations quantitative analysis of accounting/management data and qualitative data in the form of observations gained from service delivery contribute to decision making within the organisation and inform reporting of performance to regulators, further discussed in chapter 6. Such reports are therefore a good source of both qualitative and quantitative data (Wall, 2005) for analysis of health service delivery.

The production model as used by accountants and economists provides a method to measure the value of resources generated in health service delivery, recognising the difficulties of measurement (Chapter 2, 2.5; Chapter 3, 3.4). Additional challenges for the measurement of "knowledge capital" in health arise, particularly as the "public goods" dimensions of the capital are "non-excludable" in part (Chapter 3, 3.3). As argued in chapter 3, 3.6, therefore, the most feasible method for the measurement of "knowledge capital" in health services is through estimation of the inputs of its joint production. Although a more direct and robust basis may be ideal, the inseparability of the costs of inputs and uncertainty of future value of outputs, make deriving insights through indirect means using available data the only plausible approach.

The impact of factors in the environment on key stakeholders of an organisation, as Mays et al. (2005) suggest, is best understood by those managing the organisation. For this exploratory study, therefore, qualitative data in the form of service provider perspective is required. Such data can be collected through structured, semi-structured or unstructured interviews and observations. A structured format focuses the data collection to specific areas as defined by the researchers facilitating data capture and analysis. This format, however, does not provide for clarification of issues by researcher or participant, with a risk of researcher view being superimposed or new views raised by participants not being captured. An unstructured format for data collection whereas may better capture emerging views from participants. The data collected, however, may be unwieldy and analysis cumbersome and potentially result in data not being pertinent to the study. A semi-structured format provides some structure for a dialogue between researcher and participants and is able to accommodate emerging views in the course of data collection, as required for this case study.

Furthermore, interviews as a method of data collection can capture individual sensitivities and perceptions thereby providing rich meaningful data in the form of opinion and comments from different perspectives. This makes it suitable for exploring what health service providers understand by “knowledge capital". On the other hand, data from observations requires some prior understanding of what is being observed for it to be meaningful.

Qualitative data generated from observations and interviews, as Ritchie (2005) suggests, can be unwieldy and tangled in nature. The analysis of such qualitative data is facilitated by Computer Aided Qualitative Analysis Systems (CAQAS), specialist packages such as Nudist, Atlas/ti and WinMax. These packages can help in data administration and archiving of qualitative data when compared with manual processing. Conventional word processing through "Microsoft Word" also supports transcription and summarisation for synthesis of the narrative provided by such complex data.

Early empirical studies on “knowledge capital”, as Brennan and Connell (2000) identified, used surveys (interviews, questionnaires and focus groups), analysis of annual reports and case study methodologies. As understanding of the phenomenon is emerging, a greater proportion of these studies used case study methodology where the research objective included defining the characteristics of “knowledge capital” in organisations (Brennan and Connell, 2000). None of the studies, however, addressed the challenges of measurement of "knowledge capital" as a resource in health (Chapter 3,3.5).

5.3. Research design and methods used in this empirical study

The definition and measurement of "knowledge capital" requires understanding of the context of its co-creation with health services (Chapters 2, 2.6; 3, 3.6). Case study as a design was therefore adopted for this empirical enquiry of this contemporary phenomenon within a health service context where the boundaries between these two cannot be clearly distinguished (Yin, 2005). This design was chosen as appropriate, as this is the first study which use the models developed in chapter 4, 4.3, 4.5, as frameworks for defining and measuring "knowledge capital" in health. Furthermore, qualitative and quantitative data gathered through observations, interviews and analysis of management reports helped provide answers to contextual, descriptive and enumerative forms of questions (section 5.2.2).

Case study as a research strategy accommodated the variety of evidence such as documents, interviews and observations necessary to understand "knowledge capital" in health. The potential weakness in single case study design of generating theoretical propositions that cannot be generalisable to other health settings (Grbich, 1999) was addressed by using data from qualitative and quantitative approaches. The data from these two approaches complemented each other by providing corroboration and contextual relevance for interpretations (Johnson and Onwuegbuzie, 2004).

The use of quantitative and qualitative techniques within the case study design helped derive evidence in context through a narrative synthesis which can help inform policy making (section 5, 5.2). Quantitative data using management accountancy methods within the NHS costing guidelines (Chapter 6, 6.2.5) enabled the use of provider insights in the identification, disaggregation and estimation of the costs of inputs of PH service provision (Drury, 2006; section 5.2.2). The choice of the PH services at Papworth Hospital as unit of analysis for this study is discussed next.

5.4. Choice of PH services at Papworth Hospital for Case Study

This study explored how far it is possible to identify the value of resources that are devoted to “knowledge generation” in health service provision as a means of measuring "knowledge capital" generated in health. In this context, specialised health service providers aim to deliver emergent and developmental services and create new explicit knowledge (DH, 1998a, 2001b). The explicit knowledge creation, in other words, research capacity that therefore exists in parallel with service delivery is more visible.

European Society of Cardiology guidelines define it:

> “*As a group of diseases associated with thickening of the arterial walls in the lungs leading to reduced flow of blood in the lungs, putting a strain on the right side of the heart leading to its failure and premature death.*”

An emerging service such as Pulmonary Hypertension (PH), as discussed next, was chosen as the unit of analysis for exploring how far the observed costs are truly joint costs for service delivery and knowledge creation. Papworth hospital as an accredited PH specialised services centre (DH, 2001b) was therefore chosen as the organisational setting for this study.

5.4.1 Choice of pulmonary hypertension (PH) services as case study

A specialised health services for pulmonary hypertension (PH), is a developing area of care, therefore knowledge related to the delivery of such a service is changing fast and is not embedded (Galie et al., 2004, 2009). At the same time, the planning and accounting systems and processes within the NHS did not accommodate the data and information needs of innovation and definition of this emerging and developmental intervention. New routines and processes were therefore developing within Papworth hospital to accommodate the data and information needs of PH specialised services.

The Department of Health listed Pulmonary Hypertension (PH) services as National Specialised Services in Definitions Set No 29, "Specialised Respiratory Services (Adult)" (DH, 1998, 2001b), because of the low volume of patients, the limited understanding of this condition, the need for research and new knowledge in this condition are necessary. Treatment for PH services is thus commissioned as a specialised service in the NHS in England and Wales.

Specialised services require high cost or scarce resources for a very small proportion of the population, as discussed further in chapter 6, 6.2.4. This makes commissioning difficult at the local level, so PH services in UK are commissioned at the national level in order to manage financial risk, develop scarce skills, undertake and develop research into the condition. The reimbursement to specialist hospitals for provision of PH service in the UK is estimated using the NHS national tariff as applicable for respiratory conditions with an additional reimbursement for the PH drugs utilised. The need for knowledge on the demographics of patients and usage of resources was clearly articulated in the report commissioned by the National Specialised Commissioning Advisory Group (NSCAG). Such data is seen as necessary for the development of appropriate resource allocation and financial risk sharing arrangements (DH, 2001b).

PH services provision is developing together with processes for the development of skills, knowledge and capacity (DH, 1998a, 2001b), therefore suited for this study. The National

Specialised Advisory Group listed this condition with designated specialist centres. This is to ensure robust population pool for skills development and research for this condition with a small cohort of identified patients (DH, 1998, 2001b).

Some protocol and guidelines (Appendix 7) are provided for PH services with continuing research and development undertaken by nationally designated centres within the NHS to develop understanding and services for this condition. These patients exhibit symptoms similar to a variety of specialities such as respiratory, cardiology, haematology and rheumatology (Galie et al., 2004, 2009). The interactions between mechanisms that initiate and progress the pathological changes that result in PH are not well understood so research and developments in treatments were ongoing at the time of this study. The provision of PH specialised services was thus chosen for this study on the co-creation of knowledge based resources and health services.

5.4.2 Papworth NHS Hospital Trust as the organisation setting for the study

In terms or organisational setting, Papworth hospital is a national specialist services designated centre for PH services, and a centre for heart and lung transplant surgery (www.papworthhospital.nhs.uk). Additionally, it is the sole centre in the UK to perform pulmonary thromboendarterectomy (PTE) surgery, the surgical treatment option available for this condition. The hospital enjoys an international reputation for providing specialised services in cardiology, cardiothoracic surgery and respiratory medicine. There is history of testing new interventions in this organisation, for example, it is one of the UK centres trialling Ventricular-Assist Device (VAD) therapy or the implanting of a mechanical pump to provide a temporary rest for the patient's heart. This is a hospital that routinely generates and develops services in tandem with health service provision therefore provided an appropriate organisational setting for this study.

Papworth hospital as a national heart and lung transplantation centre and considered a pioneer in these specialities (www.papworthhospital.nhs.uk). The hospital treats around 19,000 inpatients and 20,000 outpatients each year, with 1200 staff, 230 beds and an annual income of £86m in 2005/06 (Papworth Foundation Hospital NHS Trust, 2006). The majority of Papworth hospital's funding is through its contracts largely for specialist services provision nationally. A smaller proportion of income is generated from services for secondary care in cardiac and respiratory diseases, such as catheterisation, for its local population. In addition, it attracts funding for research projects and donations through its reputation as a leading specialist heart and lung hospital. The total income from various sources for the financial year 2005-06 as accounted in the audited accounts of the hospital is as in Table 5.1.

Table 5.1: Total income of Papworth Hospital financial year 2005-2006

Income, Patient activity	**£78.5m**	**(91%)**
Other Income including, Research & Donations	**£7.4m**	**(9%)**
Total Income	**£86.0m**	**(100%)**

Source: (Papworth Foundation Hospital NHS Trusts, 2006)

In the year 2005-06, Papworth hospital's income of £86m includes income from services provided to NHS patients of £78.5m, 91percent of the total income. The £7.4m accounted as other income includes, £925k from the NHS research levy funding as part of the Cambridge research consortium. Further included are £2.4m of non-NHS funds generated, £1.3m from other research projects and £1.1m from donations. In other words income from such non-patient related services or knowledge based services accounts for 9 percent of total income.

5.5. Phases and methods of case study on Papworth Hospital PH service provision

This case study explored the nature and measurement of “knowledge capital” in health services through examining the joint production of knowledge and knowledge based resources during PH service provision. The models "knowledge creation cycle" and "dimensions of knowledge capital in health" (Chapter 4, 4.3, 4.5), developed through literature reviews, were used as frameworks for the identification and measurement of “knowledge capital” in order to assess its importance and the scale of it as a resource in health service.

To understand the concept of "knowledge capital" in the health context answers to the following questions were explored:

1. What do key managers/ stakeholders understand by “knowledge capital”?
2. How can "knowledge capital" be expressed in health service accounts?
3. How can “knowledge capital” be measured from health accounts?

Factors that should be considered in managing and funding the creation of "knowledge capital" and the costs and benefits of "knowledge capital" generation in a hospital emerged. This exploratory case study of the provision of PH specialised services at Papworth hospital was undertaken by an exploratory pilot and two data collection phases as detailed next.

5.6. Phases of and methods used in case study

An exploratory pilot was undertaken first then qualitative and quantitative data was collected in two phases, Phase I and Phase II.

Phase I, using the model "knowledge creation cycle in health" (Chapter 4, 4.3) set out to understand the nature and context of PH service provision and co-creation of "knowledge capital" at Papworth hospital. Phase I of this study undertook the identification, disaggregation and costing of the resource inputs and the co-generated outputs in PH service provision using Papworth hospital PH team's tacit and explicit knowledge (section 5.2). As a feasible option, measurements were based on an inputs pricing approach used by economists and accountants (Chapter 2, 2.4, Chapter 3, 3.4).

Phase II explored the component parts of "knowledge capital" in health service from a strategic management perspective of Papworth hospital. Analysis of the hospital board of directors' views using the model "dimensions of knowledge capital in health" (Chapter 4, 4.5) as a framework categorised it, to the extent possible. Capital asset pricing methods (Chapter 2, 2.5) supported the derivation of a minimum estimate of the stock of this asset as a start for its measurement.

The data sources and data currently used within Papworth hospital were initially reviewed to establish the management purpose of such data. In Phases I and II qualitative and quantitative data were collected using observations of meetings, semi-structured interviews of staff and management report analysis. Qualitative data was analysed using the models "knowledge capital cycle in health" and "dimensions of knowledge capital in health"

(Chapter 4, 4.3) as frameworks for narrative analysis. Quantitative data was derived using management accountancy reports and methods, which are subject to external audit, in both phases of this study. Such data provided a validation and reliability check for data collected by qualitative methods (section 5.2).

Trustworthiness of the data was ensured in this study by audio recording interviews and respondent verification of content and validity. Furthermore, the interview tapes were transcribed by persons outside the study and read twice by the researcher, once to confirm the accuracy of transcription and subsequently, to analyse data.

Interviewing participants individually in their offices and open questioning helped to provide the space for the PH team and the Board at Papworth hospital to reflect on their experience in relation to intangible and additional outputs of service provision. This sharing of reflections and thoughts by the participants in a focused manner, without imposing researcher view, helped to inductively generate an explanatory theory for the phenomenon of "knowledge capital" in health.

This study used "Microsoft Word" for word processing and analysis of qualitative data and "Microsoft Excel" for quantitative data as used routinely by Papworth Hospital (section 5.2.2). The researcher's prior experience of using these packages in the NHS made data processing and use of data generated easier and more meaningful in discussions and engagement of the PH service team. Using reports based on the hospital's management accounting methods provided internal credibility for the analysis of resource costs and benefits generated by this research with a practical application for Papworth hospital. Furthermore, this makes the study results adaptable for use within the NHS.

The key activities undertaken in Phase I and II of the case study are as follows:

1. Identification and mapping of the resources used as inputs to deliver the specialised PH services and research using the model of “knowledge creation cycle in health” (Chapter 4, 4.3).
2. Estimation of the cost of resources (tangible and intangible) identified as inputs for specialised PH services and research provision, using the method of full absorption costs and recommended by the NHS costing guidelines (Chapter 5, 5.3, DH, 2005a, 2007c, 2008a).
3. Disentangle and identify, among the resources used, those assigned to PH clinical services, research and those with joint outputs, where possible.
4. Separate out the cost of PH clinical service provision by using the revenue attributable to provision of PH services estimated using the NHS HRG tariffs (DH, 2003b) applied in the year of study.
5. Identify and categorise the different knowledge based outputs and “externalities” created by health service provision, using the model "dimensions of knowledge capital in health” (Chapter 4, 4.5).
6. Analyse charitable funds generated by the PH team from research and donation from the time of the team being formed, to provide a basis for estimation of the stock of "knowledge capital".
7. Highlight the implications for resource allocation and performance management arrangements in the NHS of the co-generation of "knowledge capital" in service provision.

5.6.1 Ethical considerations

Prior to commencement an application was made to Huntingdon Research Ethics Committee, which reviewed the project at Papworth Hospital and issued a favourable ethical opinion. Following approval from this Ethics committee, the R&D Department of Papworth Hospital's Trust granted management approval for this study.

In both Phase I and Phase II, at the start of the interviews, interviewees were informed and consented using the ethics committee approved information sheet (Appendix 1) and consent form (Appendix 2). All interview data was transcribed and participants' anonymity preserved, to the extent possible, in presentation of findings to the PH team and Board of Directors. The participants were free to consent and to withdraw at any stage of this study. To ensure validity and reliability of findings the PH services team the summary of the Phase I findings was shared with the team in an organisation research meeting presentation. Similarly, in Phase II, the Board of Directors received a summary of phase I findings as part of their interviews and the findings of Phase II as papers of Papworth hospital research sub-committee.

5.6.2 Exploratory Pilot

An initial visit to Papworth hospital explored the potential for this research study, which resulted in the researcher providing 6 months consultancy services for "Foundation Trust" status application (DH, 2002c). This involved financial planning and contracting support to the director of finance. A further short-term costing consultancy over a 9 months period was commissioned by the director of finance. The role involved leading the project on developing a costing and benchmarking strategy to identify the hospitals clinical service level costs.

That project established and agreed with cardiac and thoracic service managers the units for measuring the activities of these services called “currencies”, for service planning purposes. These units of measure or currencies helped map resources used for service provision and establish service level costs. The cost and activity information was corroborated with the existing financial, costing and performance management reports. The linking of costs and activity in this way was a start towards service level costing and the provision of an additional aspect of its budgeting and financial management strategy at Papworth Hospital. This project provided a good objective preparatory audit of the Papworth hospital's management accounting reports, processes and systems.

Exploratory review of processes and routine data sources

In the consultancy project the following reports were identified as data sources: contract monitoring reports, R&D reports, budgetary reports, reference cost reports, referral letters, and clinical notes from other providers. These reports are grouped based on the primary management use for the data collected. Such uses include providing clinical care, research, service planning, financial allocation, commissioning and performance reporting. The sources of routine data collection for patient records, commissioning and performance management records at the specialist hospital were reviewed. The data on patients referred to hospital that comes from, or provided to, the primary care trust, secondary care provider, and other academic research-intensive tertiary provider was reviewed.

Analysis undertaken at exploratory stage

As part of the exploratory work, over the first 6 months, background data was analysed to understand the activity and cost inputs of the hospital's costing database. Tables of activity and cost data were derived from the hospital's budget statements and income profile to provide a framework for meaningful discussion with key managers and staff. In addition, qualitative data was collected at the hospital through observation and recording of service planning meetings. Such data provided the detailed qualitative and quantitative data required to support what Grbich (1999) calls an utilisation-focused perspective for this study. This data helped understand the workflow and resources actually being used in Papworth hospital for service provision.

5.6.3 Phase I: Mapping and costing of inputs for delivery of PH services

In Phase I, a non-participative observation of a pre-ward round meeting and a commissioning meeting of the PH team was undertaken for the researcher to get familiar with the operational reality of the PH services provision at Papworth hospital. The observation exercises, further served to underline the shift in the role of the researcher from that of a management consultant providing advice to Papworth hospital to that of a researcher undertaking phase I of this study. The details of qualitative and quantitative data collection methods undertaken in Phase I are detailed next.

Phase I- Observations

In phase I of this study direct non-participant observations of a PH ward round, an outpatient clinic, a clinical multidisciplinary meeting, PH team business and a commissioning contract meeting, was undertaken at Papworth hospital over a six months period. In the notes of these observations, what was said is accepted as reflecting the interviewee's views and experience of what drives the PH service and the organisation.

These observations provided a platform to explore how staff from different functional disciplines interact and understand how and what kind of knowledge was shared in the process of service delivery. Notes were made after clinics and ward rounds, while business meetings were audio taped for reference. Notes made from such observations were checked with the PH clinical consultant and the respiratory directorate general manager for accuracy and validity.

The observations focused on the knowledge used and processes for sharing it in clinical and management decision within the framework of "the knowledge creation in health" (Chapter 4, 4.3). This data provided descriptive and explanatory accounts of the organisational reality, processes and work practices of the hospital as part of the wider complex NHS environment in this case study (section 5.2.1). Insights were drawn from these observations, through intuitive interpretation as evidence of the modes of knowledge creation processes (Chapter 2, 2.5) during the course of PH specialised service provision. Furthermore, such analysis provided the experiential, conceptual, systemic and routine knowledge (Chapter 2, 2.3) in the health context.

As a result of leading an earlier consultancy project at the hospital the author was embedded within the hospital, enabling gathering of some meaningful primary background data. Additionally, the author's presence in meetings as a researcher and a passive participant was accepted with full and free access provided to discussions. The shift in role from consultant to researcher was made clear at the start of interviews and business meetings and permission gained to audio record meetings. The PH service team's perceptions, however, required managing to ensure that the researcher was not seen as an additional resource for their routine business activities. In order to manage this perception and ensure clarity and objectivity, the nature of the researcher's role as an external consultant or as a researcher was made explicit at the first meeting with the PH service team and reiterated at the start of observed business meetings.

Phase I: Interviews

Meetings with the director of finance, the director of research, the PH consultant physician and the general manager of the respiratory medicine directorate helped identify the staff associated with PH services within Papworth hospital. The list of interviewees were PH consultant physician, PH research nurse, the thoracic ward sister, PH specialist nurse, the contracts manager, the finance manager, and the specialised services manager.

Phase I interviews were semi-structured, using a list of broad questions (Appendix 3) generated from the literature review, initial observation and prior knowledge of the NHS costing systems. The interviews were about an hour long and audio recorded, transcribed, checked and coded as necessary for analysis. Furthermore, at the time of study the PH service team consisting of a respiratory physician, cardiologist, PH nurse, ward sister, social worker, research nurse, clinical secretary and the ward clerk undertook a service planning meeting to map the activities and flow of patients and information. This serendipitous meeting supported the capture of data on processes, activities and soft resources used in PH service provision, which had internal credibility.

Using a pre-prepared interview guide (Appendix 3) enabled relevance, consistency and coverage of issues with all the interview participants (section 5.2.2). The questions enabled engagement of the PH team whilst providing a focus for the identification of resources used and the sources of funding for these resources. The semi-structured interview format for this case study meant meaningful data was captured, including emerging insights (section 5.2). The cost tables and resource profiles derived from financial budgetary reports (Chapter 7, 7.3.1) provided further structure for engagement of the PH team. Discussions in the meeting validated the quantitative data thereby providing internal credibility (section 5.2) for the costed resource profiles produced (Chapter 7, 7.3).

Phase I: Qualitative data analysis

"Knowledge creation cycle in health" was used as a framework to analyse the transcripts to draw out themes from the narrative. This provided an understanding of the processes within health service delivery that helped create knowledge and facilitated its capture and sharing. Further, this analysis identified the experiential, conceptual, systemic and routine knowledge (Chapter 2, 2.3.2) generated and utilised in PH services provision (Chapter 7, 7.2.5).

In addition, descriptions of the clinical services, research, skills, education and service development processes at Papworth hospital was provided by analysis and synthesis of interview data. This data was used on the basis that what people thought they were doing was interpreted as what occurred in practice. Such analysis highlighted the nature of resources, including knowledge based ones, used to provide specialist clinical service, research, education and skills development by the different disciplinary groups (Chapter 7, 7.2.2). Furthermore, it identified the organisational and funding structures and routines that helped the PH team to create and use knowledge generated by PH specialised services provision.

Phase I-Quantitative method

Papworth hospital financial budgeting and costing databases provided quantitative activity and cost data in this study. Such data is collected and maintained at Papworth hospital within the financial and costing guidelines set for NHS organisations (DH, 2005a, 2007c, 2008a), thus providing some consistency within the NHS.

Quantitative data collection

The data about individual patients and the PH service provided to the patient in the hospital was captured on a research database setup by PH services team and the Patient Activity system (PAS). Clinical activity data is captured on a contract monitoring database reviewed and forwarded to the Department of Health. This clinical activity data from the contract monitoring database developed within Papworth hospital was downloaded into "Microsoft Excel" spreadsheets for generating estimates of revenue based on HRG tariffs for PH services. Both systems provided quantitative data on patient activity.

Cost data for this study was collected from "BPlan" costing database (a commercial costing database accredited for use in the NHS) used by Papworth hospital for reporting costs to the Department of Health (DH, 2005a, 2007c). This database therefore is in accordance with the costing principles of full costs as stipulated by the NHS costing guidelines (DH, 2005a) discussed in chapter 6, 6.2.5. "BPlan" costing database and "Microsoft Excel" spreadsheets supported the quantitative data management of the study.

Audited annual report and accounts for 2005-06, the reference cost report for 2004-05, the contract monitoring reports for year 2005-06, the report on PH services contract reports to NSCAG and the annual research report submission for 2005-06 were reviewed. This exercise provided the crosscheck for verifying data on PH specialised services activity, resources used and cost of service provision at the hospital.

Quantitative data analysis

Management accountancy principles and method of full absorption costs as per NHS (Chapter 6, 6.2.5) were used as a framework to identify and cost the activities and resources utilised. This data was analysed and reconciled to the clinical activity producing resource profiles which were costed using a "bottom up" approach from Papworth hospital's internal budgetary reports and BPlan costing database reports. The specialist drugs used were not included in this exercise as the costs of such drugs were reimbursed on actual usage through a distinctly separate process.

For quantitative analysis, "activity based costing" methodology was adopted using a "bottom up" approach to identify the resources used in the delivery of specialised services (DH, 1998). Activity and resources utilised for PH service was disaggregated to the units of currencies derived (Table 7.1) using PH service team's knowledge and understanding of the service. In line with the NHS costing guidelines (DH, 2005a, 2007c; Chapter 6, 6.2.5) the costs for the provision of routine clinical services component of PH services were estimated in this study on a full absorption basis (Chapter 2, 2.5.1). The short and long term funding sources of the resources were established distinguishing between revenues from clinical services, research and non-NHS sources.

The developed costed resource profiles (Chapter 7, 7.4) were agreed with clinicians, service planning and contracting managers, and the finance team. Using the hospital's management accountancy reports and methods enabled getting the clinical staff engaged in the estimation of resources and costs of service provision as recommended by the Department of Health (DH, 2005a, 2007c).

The NHS Charitable Trust Funds (Chapter 6, 6.2.6) income and expenditure accounts were drawn up from the statutory records maintained. These accounts were analysed and the funds utilised from these to support PH teams activity calculated and verified. The overall financial status of the hospital was reviewed (Papworth Hospital Annual accounts, 2006). Next the details of costing methods used are provided.

Phase I- Costing methods of the study

Papworth hospital collects data on NHS format clinical contracting database, to accounts for all its NHS clinical activity to commissioners of health service through the NHS central clearing system. Data on number of patients treated and the kind of services provided is transferred to the BPlan costing database for producing reference cost submissions.

The costing of resources in this study followed the definitions used by NHS hospitals for financial reporting, and complies with the NHS costing guidelines (Chapter 6, 6.2.5). Costs were classified as direct, indirect and overhead costs as per these guidelines detailed in chapter 6, 6.2.5. Costs were classified into fixed, semi-variable and variable (Drury, 2006). Fixed costs are costs that are not affected by changes in activity through the year (Drury, 2006). Semi-variable costs are costs that are fixed to a given level of activity, but there is a step change when activity rises or falls by a given level (Drury, 2006), for example nursing staff costs. Variable costs are those that vary directly with changes in activity (Drury, 2006), for example the cost of tests (DH, 2005a, 2007c, 2008a).

Costs pertaining to the service were calculated on a full absorption basis, which is compliant with NHS costing principles (DH, 2005a, 2007c, 2008a). The detailed resources were costed bottom up to arrive at total costs using the costs as per budgets, management accounts and the costing database. The fixed and variable costs were identified based on the relationship of cost to the increase or decrease in clinical activity as understood by the PH services team. Direct, indirect and overhead costs were included in the calculations. The detailed costs input such as ECG, X-Ray and so on were estimated after cross validation with the total activity for such resources and the costs for that particular category of resource.

Staff Costs

The multidisciplinary team costs are calculated to include the staff members' gross salary and employer's national insurance and pension contributions. Staff costs were derived from management accounting reports and staff payroll records. In addition, a share of the hospital institutional overhead was included to reflect the cost of providing administrative services, such as personnel, training and finance, related to the PH services team. The costs of medical staff, funded by the Deanery as postgraduate trainees are excluded. This was because the cost of explicit capacity development or in other words research capacity was distinctly funded by the health system.

Reimbursement for PH clinical Services

The reimbursement to the hospital from PCTs was made on the basis of a variety of HRGs (Table 7.18) under Payment by Results (Chapter 6, 6.2.7; DH, 2002d). Specialised services activities, however, were not adequately covered by robust HRGs tariff estimations or in the payment by results regime at the time of this study. At Papworth, the primary activity of the contact was assigned its HRG code and then the clinician code was used by the hospital system as an additional filter to separate PH services activities. The national tariff prices attached to the primary HRGs code of the activity as per PbR regime applicable, at the time of this study, was used to estimate the reimbursement from the NHS for clinical services. The financial impact of the "payment by results" regime (DH, 2002d) on the hospital was further clarified by the detailed comparison of the national average price and the costs of resources used by the hospital.

Test Costs

The cost of individual tests was established by reviewing the hospital's costing database reports and the clinical activities report of clinical support departments such as pathology, radiology, physiotherapy. The unit cost of tests was calculated by dividing the total costs of the relevant department, such as pathology, radiology etc., with the weighted activity of that department. The cost for each of the tests and procedures required for the PH services was derived from the "BPlan" costing database of the hospital. The costing database followed the costing methodology required by the NHS costing manual 2005 (DH, 2005a) and the cost reports produced for National Reference Cost submissions (DH, 2002d). Costs are pooled for each service by a top down process then allocated to activities based on a local bottom up identification of key activities that impact cost of each service. The unit cost of tests, ECGs, right heart catheters and other items used in this study were derived by pooling these departments' direct, indirect and overhead costs and dividing that by the relevant department's activities. Where the hospital did not produce a unit cost for a procedure e.g. chest X-rays, national tariff figures were used.

Ward Costs

The ward cost for PH inpatients was estimated as the cost of a ward day on the thoracic ward minus the clinical staff cost, which was calculated as part of the multidisciplinary team and as a fixed cost. The multidisciplinary team cost was allocated to the different categories of treatment in proportion to the time spent by the team, as understood by the service delivery team. The multidisciplinary team cost was treated as a fixed cost and allocated between assessments and follow-up in proportion to assessment and follow-up activity.

In summary, this study methodology was used, in the earlier consultancy project, for estimating the cost of other cardiac and respiratory specialised services provided by Papworth hospital. Data on ward and test costs was therefore available to corroborate the findings from this study of PH specialised services. The detailed resource mapping undertaken at Papworth hospital contributed to the negotiation on national development of specialised services by providing information on the kind of activities and the resources used in providing specialised cardiac and thoracic services.

5.6.4 Phase II: Identifying dimensions of "knowledge capital" in health

In Phase II, the senior executive management team of Papworth hospital as those responsible for the strategic management of the hospital were interviewed. They are required to deliver health services that meet targets set by national policies (DH, 1999, 2005). Their views on what helped or hindered the hospital to deliver its strategic objective of providing and developing clinical services, research and skills were gathered. An observation of the research and education sub-committee of the hospital was planned at the start of the study. The Board of Governors were observed instead to provide an understanding of the strategy formulation and accountability framework of the organisation.

Quantitative data was extracted from the hospitals NHS charitable trust funds accounts (Chapter 6, 6.2.6) and analysed. The details of the interviews and observation and analysis undertaken in this phase are detailed next.

Phase II - Interviews

In Phase II nine semi-structured interviews were undertaken using an interview guide (Appendix 4), and audio recorded. The Chair of the research committee (a non-Executive director), the Chief Executive, the directors of operations, medicine, R&D, finance, human resources, nursing and capital project were interviewed. All the interviewees were members of the research and education sub-committee, which is a sub-committee of the board of directors at Papworth hospital. These interviews explored how they saw their organisation in terms of service and knowledge creation discussing factors that hindered and those that aided knowledge creation and service delivery.

Individual interview appointments were made with each executive director and the non-executive director for research. At the start of interviews, the findings of Phase I as interpreted within the “knowledge capital in health” framework (Chapter 4) were shared. Following the scene setting, interviews were semi-structured using a list of questions (Appendix 4) and findings from phase I of the study. The questions provide a guide for the interviews which ensured data relevant to the nature and measure of "knowledge capital" were gathered (section 5.2.2). An inductive approach through open questioning was adopted to gather views of the phenomena, though the term “knowledge capital” was not used in the interview questions. The terms used during the interview were research and service development, patient satisfaction, organisational reputation, staff turnover, which members of the Board were familiar with in the management of the hospital, rather than as "knowledge capital". By providing privacy in individual interviews, rich meaningful data in the form of comments, opinion and views from different management functional perspectives was obtained.

Such data provided a basis for the comparison of the operational perspective with the strategic vision and direction of the hospital. Furthermore, it provided a basis for understanding the multifaceted and complex nature of “knowledge capital” and its categorisation, though the component parts were not referred to as "relational capital", "public goods in health", "capacity in health".

To ensure the trustworthiness and validity of interpretation, emerging themes were discussed in supervisory team meetings and discussed with the director of finance. Presentation of the findings was made in person to the director of finance while the other participants of phase II received the analysis in the form of slides. The findings slides were included as an agenda item on papers to a meeting of the research and education committee of Papworth hospital.

Phase II-Observations

An observation of the research and education sub-committee of the board of directors was planned with intentions of exploring whether and how “knowledge capital” was considered in formulating the strategic direction of Papworth hospital. The schedule of the meetings did not permit this. A Board of Governors meeting was observed instead, as this new body was charged with providing advice and local direction to the organisation (DH, 2006c). As the agenda of the observed meeting included the performance report on the quality of service, the observation provided data on issues perceived as important such as skills development, research, and patient education.

Phase II- Qualitative data analysis

The interview transcripts were read in depth to highlight emerging themes in the interviews. Transcripts of interviews were line numbered to provide transparency and to provide an auditable trail for coding and the description of the dimensions of “knowledge capital”.

The themes identified were coded and compared with categories identified in the model "dimensions of knowledge capital in health" (Chapter 4, 4.5). An iterative approach was used to work with this data to seek patterns, check the recurrence of patterns and identify anomalies. A thematic approach with “dimensions of knowledge capital in health” (Chapter 4, 4.5) as a framework was used to analyse the data from these interviews. This analysis formed the basis for categorisation of knowledge based outputs using the "dimensions of knowledge capital in health".

Emerging themes were identified and analysed for similarities and divergences in relation to the dimensions of "knowledge capital" identified in other industry studies. Similarities and divergences of themes were further examined in the context of the changing policy environment of the organisation. Different and emerging category of "public goods in health" and "capacity in health" were identified and described. As suggested by Cresswell (1998) such data analysis was to enable the development of naturalistic generalisation. Direct quotes from the transcripts were provided in findings to demonstrate that conclusions were drawn directly from the data and to illustrate interpretation with evidence (Chapter 7, 7.6.1).

Analysis of the phase II interviews provided an understanding of how the different structures and changes in NHS policies affected the effectiveness of the hospital strategy for service provision including knowledge generation. Furthermore, it provided an understanding of the organisation's perspective on its outputs in the context of such changing policies as “Payment by Results”, “Foundation Trust”, “Practice led Commissioning”, “Specialised Services Commissioning” and R&D policies.

Phase II Quantitative data

The statutory returns on R&D provided quantitative data on resources specifically financed from research funding external to the NHS. The income and expenditure reports of the PH services charitable funds and research funds maintained by the hospital to fulfil their statutory obligation to the Charities Commission (Chapter 6, 6.2.6) provided data on funds generated from research, charitable donations and fund raising activities.

Data from the PH charitable trust funds from the year 1999 to 2007 was downloaded into "Microsoft Excel" spreadsheet from the Charitable Trust Fund system at Papworth Hospital.

Phase II Analysis of Charitable Funds Income & Expenditure

The charitable trust fund accounts pertaining to PH were analysed by creating a cumulative income and expenditure of these funds for a period of 8 years 1999-2006. This time frame was chosen as this was the timeframe when PH service was established as a separate service at the hospital. The income generated by the PH team as PH Charitable Trust funds was analysed as research funds and other charitable funds. The level of financial support provided by these funds to support the provision of PH service at Papworth hospital over the eight year period was established through analysis of the expenditure of these funds. The model of "dimensions of knowledge capital in health" (Chapter 4, 4.5) was used as a framework to analyse the income and expenditure of PH charitable trust funds.

5.6.6 Changes made to the design during study

The initial plan was to interview the service team to chart the PH patient's journey within the hospital and the information flow from the time of referral. However, during the study the service manager called a service team meeting with the objective of streamlining the processes in the department. The researcher was invited to observe that meeting. This proved a useful opportunity, as the team member listed the activities undertaken by them for service provision, from the time a patient suspected of having PH was referred to the hospital. The output of the meeting was a patient pathway and the related information flow (Chapter 7, 7.2.1), which enabled the researcher to establish units of measurement for PH services through the initial grouping of activities.

5.6.7 Problems encountered

The relationship between the researcher and the PH service team was not necessarily seen as independent because of the earlier consultancy work undertaken by the researcher. There was an initial expectation from the interviewees of phase I that the researcher would provide advice on how to get additional funding for their department, project or service. There was scepticism about the data used in the NHS for contracting monitoring and cost estimations nationally. However, interviewees encouraged to engage with and having worked with the researcher in establishing the income forecasts for the hospital were accepting and generous in sharing their views.

Prior to embarking on this study, non-participative observations were necessary to become familiar with the clinical service delivery processes within the hospital. Additionally, it was necessary in all observations and interviews to be explicit about the shift in the researcher's role from that of a management consultant to one of objective researcher. Despite such action, interviewees tended to move towards discussions of difficulties with and development of specific HRG codes, or commissioning and contracting issues. The interview guides (Appendix 3 & 4) helped in getting the interviews back into focus. None of the previous studies mention or refer to such issues (Habersam and Piber, 2003; Peng et al., 2007; Zigan et al., 2009), even when adopting a similar perspective of looking out from inside the organisation in studying this phenomena (Zigan et al., 2009).

5.6.8 Factors favourable for the study

The researcher's prior experience of management in the NHS enabled meaningful observations and discussions with management in this study, as May et al. (2005) suggest. The researcher's presence and recording of meetings were accepted in both clinical team meetings and commissioning meetings because of the earlier consultancy role. Notes from observations of such meetings included the different kinds of knowledge and the context in which the participants communicated and shared knowledge within the organisation. By sharing findings derived at the hospital research meeting contextual validity and objectivity of data was established. Professional accountancy qualifications and contracting experience in the NHS provided the researcher with the advantage of being able to understand both the language and NHS terms used and merge into the background when observing meetings.

5.7. Summary of methods used in the case study

Papworth Hospital as one of the early providers of the developing intervention for pulmonary hypertension (Galie et al., 2004, 2009), provided an appropriate unit of analysis for this study of "knowledge capital" in health. Furthermore, data on the development of skills, knowledge and capacity in the course of providing PH specialised services at Papworth hospital a specialised services centre was distinctly visible (section 5.4.1; Chapter 7, 7.6). Choosing participants to represent different functions and perspectives provided the multifaceted views from operational and strategic perspectives of the organisation that was required to understand (Mays et al., 2005) impact of factors in the environment of service provision. Multiple sources of evidence, as recommended (Yin, 2005; Grbich, 1999) enabled the exploration of the construct of "knowledge capital" in a health context using a case study design (section 5.3).

The mixed methods used In Phases I and II of this case study enabled the exploration of the phenomenon of "knowledge capital" in health as constructed through the perceptions of those immersed in the multiple operational and strategic realities of an organisation delivering health service (Yin, 2005; section 5.2). The models "knowledge capital cycle in health" and "dimensions of knowledge capital in health" (Chapter 4, 4.3, 4.5) provided suitable frameworks for analysing data to make a start at defining and measuring "knowledge capital" in the health context.

The Department of Health (2001b) acknowledging the need to understand and generate data on resource usage and costs for commissioning and ensuring provision of PH services provided an additional impetus for choosing it as the unit of analysis in this study. The management accountancy approach of "bottom up" costing for estimating inputs, as discussed in Chapter 3, 3.4.1, provided a start to the identification and estimation of costs of service provision and knowledge based outputs, from a management perspective. Furthermore, the use of data and methods used for internal management within the hospital made the engagement of clinical staff possible. Such engagement thereby made feasible the disaggregation of resources and costs of joint production as discussed in Chapter 3, 3.4.

The models "knowledge creation in health" (Chapter 4, 4.3) and "dimensions of knowledge capital in health" (Chapter 4, 4.5) helped to a certain extent in the analysis of the kinds of knowledge created (Chapter 2, 2.3.2) and the joint knowledge outputs of health service provision (Chapter 3, 3.5). A joint accountancy economics approach to estimation of resources and costs of health service provision as recommended (Drummond et al., 2005; Mogyorosy and Smith, 2005; NICE, 2008) was used in this study.

5.8. Conclusion

Case study design adopted in this study allowed for an in-depth understanding of the complex process environment (Yin, 1994) of the joint production of “knowledge capital” and health service provision. The use of a mix of quantitative and qualitative methods within the case study design (section 5.3) accommodated a variety of evidence such as documents, interviews and observations. Any theoretical propositions generated in this study lend itself for generalisation to other situations (Yin, 1994; Grbich, 1999).

Case study design means generalisation of results is possible through testing of the models derived in Section I, while survey methods that support generalisation of results with statistical methods is not appropriate. Case study methodology used in this study means econometric techniques cannot be used to analyse data. Single case study was adopted rather than multiple case studies as the nature and measure of “knowledge capital” in health as adapted in Section I was being critically tested. This means the dimensions of “knowledge capital” in health needs further testing for other conditions and other health service provided as primary and secondary care. The design adopted in this study was not aiming to evaluate a specific policy. Factors that may impact resource allocation policy in health are however, highlighted from the results.

Likewise, neither is this study a cost benefit evaluation as defined by economists (Drummond et al., 2005) where cost and benefits are measured, from a societal perspective, in monetary and non-monetary terms such as clinical outcomes and quality of life. This study does, nevertheless, draw from the underlying economic principles of externalities and spillover to examine “knowledge capital” in health from an organisational management perspective (Chapter 2, 2.7; Chapter 3, 3.4.4). As the study is set in the UK, the applicability of models and further generalisation of results from this study into the wider national and international settings will need further research.

The common business environment and statutory requirements of health service organisations in the NHS (Chapter 6, 6.2) mean data derived from the accounting reports of resource use can be used (Chapter 3, 3.6; section 5.3). Furthermore, potential metrics for the identification and measurement of resources used in the co-creation of health service and “knowledge capital” can be further tested and developed within the NHS.

Next chapter 6 details the wider strategic context for the provision of PH specialised services within the health system of NHS England & Wales.

Chapter 6 Strategic context for service provision in the NHS England & Wales

6.1. Introduction

This chapter sets out the strategic context of health service provision within the NHS as the health system, the setting for this case study of PH specialised service provision at Papworth Hospital. This case study tests "knowledge creation in health" and "dimension of knowledge capital in health"(Chapter 4, 4.3, 4.5) as a structure for identifying the components and measurement of “knowledge capital” as a resource in health service provision within this wider health system (Chapter 5, 5.5).

6.2. The strategic context for the case study of PH services at Papworth Hospital

Health service delivery and "knowledge capital" are jointly produced using both explicit and less explicit processes, which make dissemination and protection of such knowledge difficult (Chapter 3, 3.5, 3.6). The context of their generation determines the value of this resource, therefore the strategic context in which health service providers in England and Wales are expected to provide services are detailed.

In order to understand the strategic context of NHS health service organisations, the organisations and structure for health service delivery in the NHS in England and Wales are described. The executive structure and policies for health provision in Scotland and Northern Ireland whilst within the NHS are separate and not explored in this study. The policies and organisational changes in provision of health services and research as applicable in England and Wales are highlighted.

At the time of the study, the Secretary of State is responsible for the NHS provision of health services for the population of U.K. The Secretary of State delivers these responsibilities through the Department of Health and the executive structures of the NHS managing the health service organisations. The NHS is a unique and complex organisational umbrella with an expenditure of £84 billion in the financial year April 2005 to March 2006 (Audit Commission, 2006), the year on which this study is based, increasing to £90.7 billion in the year April 2007 to March 2008 (Audit Commission and NAO, 2008). Under the NHS health system, there are about 600 different organisations with individual resource allocation responsibilities and operating structures, interacting and contracting with each other to provide health services for the population of England and Wales. Independent providers such as General Practitioners (GPs), pharmacists, dentists, optometrists and other private and voluntary sector providers contract with the NHS to provide primary care services. Secondary and tertiary care, which are in the main provided in a hospital setting, are provided through contracts with NHS hospital trusts and private and voluntary sector providers.

Health services for local populations are mainly commissioned by Primary Care Trusts (PCT). Primary, secondary and specialist care, including emerging treatments, are provided through contracts between NHS provider organisations and groups of commissioning organisations within a region. For provision of primary care, contracts are negotiated with GPs at national level in the form of GP's salary and expenses for their practice. Secondary and tertiary health services are commissioned by PCTs through contracts based on health service activity measured in “spells” which consists of a number of finished consultant episodes (FCEs). Every service contact the patient has with the health organisation generates an episode with a complete cycle of episodes forming an FCE. Spells are priced at a nationally set tariff based on national averages, with some specialised services such as burns and neo-natal services excluded. PCTs have responsibility for providing specialised services for their local population and can take a lead for the region on specific specialised services.

The National Specialised Services Commissioning Group commissions specialised services that are high-cost, low-volume interventions and treatments for the regional population on behalf of a group of PCTs (DH, 2007a). The risk to an individual PCT, the commissioning organisation, of funding expensive and unpredictable activity is managed through PCTs grouping together to commission such services. Such collective commissioning aims to spread and share the financial risk among the group of PCTs.

Such arrangements aim to ensure there is a robust population pool for research and skills development within the NHS for treating such conditions (DH, 1998, 2001b). Additionally, from a health system perspective such commissioning arrangements aim to manage the efficient use of scarce resources, including ensuring cohorts of patients for research in emerging conditions, within the health economy (DH, 1998, 2001b). This therefore implicitly recognises the "public goods" aspect within health service provision.

6.2.1 History of changes in the NHS in England and Wales: 1988 - 2010

The National Health Service was instituted as a nationwide public service in 1948, taking over responsibility for the hospitals and the charitable donations that created these hospitals (Rivett, 1998). Since then, NHS organisations in the in England and Wales in the last twenty year period have been providing health services within a history of change (Rivett, 1998, 2010) to organisational structures, responsibilities and policies.

Table 6.1: List of changes in the NHS from the years 1988-2010

1988	NHS review announced
1989	Working for Patients (NHS reforms)
1990	GP's new contract – Financial Management agenda
1991	The Health of the Nation
1994	Regions reduced to 8
1996	Districts & FHSAs united
1998	NHS Direct
1999	NICE; Primary Care Groups
2000	Commission for Health Improvement
2001	Wanless on NHS finance
2002	'Devolution day' & funding increases
2003	GPs and Consultants' new contract
2004	First Foundation Trusts
2005	Payment by Results
2006	SHAs cut to 10
2007	Ara Darzi report; public smoking ban
2008	Leading local change, High quality for All
2009	National Leadership Council
2010	Liberating the NHS (current changes)

Source: Rivett, 1998, 2010

In the early 1980s, as the numbers of patients waiting for health service grew, evidence-based medicine, clinical effectiveness and medical audit all came to the forefront as a means of managing the effective and efficient delivery of health service in the UK. The NHS thus entered an era of local accountability for resources used by health service organisations and accepts the notion of giving choice of providers for patients.

Throughout the last twenty year period, the NHS has been involved in the formation, dissolution and rearrangement of the structure and responsibilities of NHS authorities and trusts. First the White Paper, *Working for Patients* (DH, 1989) the NHS and Community Care Act 1990 set out a new contract for GPs and the introduction of the '*internal market'* for secondary and tertiary services. GP contracts for primary care provision moved from a reimbursement based system to one of being accountable for their service provision in terms of resource use and patient satisfaction (DH, 1989). In terms of secondary and tertiary care, an "internal market" was established with contracts between provider hospitals Trusts and health authorities commissioning care. Both provider Trusts and Health authorities in the NHS held accountable for financial management, quality and patient satisfaction of service provision (DH, 1989).

Then in 2005 a new type of body, the NHS Foundation Trust, was created as a "public benefits corporation" with the aim of increasing local ownership in decision making through engaging local governors to determine service provision by the local hospital (DH, 2002c, 2005c). Primary Care Trusts (PCTs) commissioned services from the provider trusts, hospitals for secondary, community, mental illness and ambulance services, as well as managing performance of GP services and the provision of primary health care (DH, 2005c). In addition to the changes in reporting lines of organisations within the NHS, the changes simultaneously introduced new systems of financial flow that is payment by results and a tariff system for pricing secondary and tertiary health service provision (DH, 2002d). Specialised services continue to be commissioned in regional and national cluster arrangements discussed later in this section. The changes in 2006 resulted in 10 strategic health authorities being responsible for the performance and financial management of Primary Care Trusts (PCTs).

The review of management structures and policies meant a significant cultural shift with the monopolistic influence of hospitals being challenged. The changes in the 1990's were driven by the political view that "internal market" that is a competitive market structure, would improve efficiencies in public services. Those early changes aimed to foster innovation in service provision, manage the growing waiting lists, and increase responsiveness to consumers of the service (DH, 1989). Following a change of government in the new millennium, "internal market" was replaced with quality and standards driven through partnerships, long-term contracts and benchmarking (DH, 1998b, 1999, 2001a). With the most recent change in government, the focus of service provision has moved towards patient choice and a patient centred service (DH, 2010).

These changes throughout have meant NHS organisations have been required to report to the Department of Health on a number of aspects of service delivery via the NHS executive structures, in monetary terms through audited financial reports. Additionally, these organisations are increasingly required to report in non-monetary terms using nationally set quality standards and statistics of patients waiting for treatment, waiting times for treatments and patient complaints relating to the local population. Every organisational and structural change has aimed to increase the local accountability of NHS organisations for resource use, efficiency and effectiveness of service provision. Consequently, as suggested by Wall (2005), public sector health service organisations may be better prepared than a private sector organisation to have data to support the identification and measurement of "knowledge capital". With a change in government there continue to be more changes in structure proposed as further discussed below.

6.2.2 Statutory regimes in the NHS

Health services in the UK are mainly funded from public finance generated from taxes and allocated via the Department of Health budget and managed through the NHS organisations. Until 2010 local responsibility for ensuring service delivery rested with the Primary Care Trusts (PCT), reporting directly to the Secretary of State through the Strategic Health Authorities (SHAs). Health services are commissioned by Primary Care Trusts from NHS Hospital Trusts, NHS Foundation Trusts (FTs) and private and voluntary sector providers. NHS Hospital Trusts and Primary Care Trusts are both accountable to the Secretary of State but NHS Foundation Trusts have different statutory and financial regimes. NHS Foundation Trusts have been created as "public benefits corporations" in law. This means an NHS Foundation Trust, while still being an NHS organisation, is subject to control through a board of directors and governors consisting of patients and members of the public and directly accountable to the British Parliament (DH, 2005c, 2010). The Independent Regulator of NHS Foundation Trusts, Monitor, undertakes external monitoring of the NHS Foundation Trusts and not the Department of Health or Strategic Health Authority (DH, 2005c).

Whilst each of these bodies within the NHS has a separate management structure, they are expected to work collectively to meet the national, regional, local services and financial goals of the Department of Health (DH, 2005c, 2006a). The clinical and financial risks faced by each body are required to be managed within this complex context. The organisations account for their finances and service provision through their audited annual accounts and annual report (DH, 2006a).

With the election of a new government in 2010, there are further changes for structures in the NHS. The changes proposed are the abolition of Strategic Health Authorities (SHA) and Primary Care Trusts (PCTs) with GPs taking responsibility for commissioning through Clinical Commissioning Groups (DH, 2010). It is not clear however how the responsibility undertaken by SHAs and PCTs in relation to specialised commissioning will be managed within the NHS. A number of quasi-NHS bodies are also being abolished with their functions being absorbed by other NHS organisations.

6.2.3 Financial regimes in the NHS

The Treasury sets the Department of Health's budget every two years for a three-year period with a year overlap. This follows the submission of proposals by the Department of Health to the Treasury in line with public service agreement objectives. Along with other government departments, the Treasury sets two departmental expenditure limits (DELs) for the Department of Health. There are separate limits for capital expenditure and for revenue spending which are governed by the Treasury's resource accounting and budgeting (RAB) regime (Audit Commission & NAO, 2008). This regime means any cash underspend or overspend by the Department in any year is carried forward into the following year's limit. Such adjustments to cash limits are passed on by the Department to the SHA which in turn are passed on to the PCTs.

The Department of Health top slices the funding it receives for research, training, education and policy initiatives. The funding for NHS Trusts is set through service level agreements with PCTs and other organisations which can be voluntary organisations. NHS Trusts were until the financial year 2004/5, statutorily required to break-even taking one year with another over three or, in some exceptional cases, five years. However, the Department of Health with the introduction of Resource Accounting and Budgeting (RAB), in April 2005, imposed an administrative requirement for NHS Trusts to match yearly expenditure with the yearly income every year. In operation, this adjustment is identified as creating a double deficit for Trusts that are in deficit as a result of the carry forward with expenditure straddling two financial years (Audit Commission, 2006). The capital expenditure of an NHS Trust has to be within its capital resource limit (CRL) and meet the Department of Health's requirements on capital and external financing.

Commissioning, Contracting and Health Resource Groups (HRG's)

The majority of revenue funding for NHS trusts is received through service level agreements with PCTs and other NHS trusts. These are not legally binding contracts and not enforceable in a court of law. These agreements are mechanisms used by the Department of Health to quantify and monitor the provision of health service by the organisations in the NHS. Disputes are settled by the Secretary of State for Health via the Strategic Health Authority (Audit Commission, 2006).

Healthcare Resource Groups (HRGs) are currently used as 'units of currency' for standardised healthcare commissioning across the health system. HRGs versions 3 and updated version 4 are standard groupings of clinically similar treatments that use common levels of healthcare resources. HRGs offer NHS organisations a framework to map and measure clinical activity in terms of the types of patients and the resources used for treatments from clinically coded data. The purpose of such a common metric is to support service planning, costing and commissioning between in the NHS organisations. The mapping of clinical codes to HRGs is still developing and not fully reliable or consistent. Such classification as it becomes reliable and consistent may provide organisations with an opportunity to benchmark treatments and service data to support trend analysis over time.

For purposes of contracting and commissioning, NHS organisations are required to submit a schedule of costs based on health resource groups (HRGs) which allow for some comparison of the relative costs of different providers. These costs are published as the National Schedule of Reference Costs which forms the basis for developing national tariffs. These tariffs are average costs derived from costs of all the providers in the NHS. The cost submissions were not however previously subject to annual external audit. NHS organisations are in the process of developing skills and know-how for the classification of costs. Questions are therefore raised on the consistency of the classification of costs and the robustness of national average costs within the NHS, derived from such data.

The joint production of the knowledge based resources that are dimensions of "knowledge capital" in health are not recognised within the cost estimations or the financial regime in the NHS. The financial resource allocation guidelines address health service delivery and knowledge generation as distinct and separate entities on a short run basis, thus not addressing the long run nature or interdependency of "knowledge capital" in health service provision.

6.2.4 Commissioning of specialised services in the NHS

Specific groups of extremely rare conditions or very unusual treatments have been commissioned on a national basis since the establishment in 1983 of the National Specialised Commissioning Advisory Group (NSCAG), later called the National Specialised Commissioning Group (NSCG). A service covering a planning population of more than a million people is defined as a specialised service within the NHS (DH, 1998a). About 45 highly specialised and politically high profile services are commissioned by the National Commissioning Group (NCG) including transplant and forensic mental health services (DH, 2001b). In England ten Specialised Commissioning Groups (SCGs) based in Strategic Health Authorities commissioned specialised services, such as haemophilia and blood and bone marrow transplantation for their regional populations. Similar arrangements apply in Scotland, Wales and Northern Ireland. Each of these services generally affects fewer than four hundred people across England or involves services where fewer than four hundred highly specialised procedures are undertaken per annum. The National Specialised Commissioning Group (NSCG) established in April 2007 was expected to oversee the national commissioning function of these specialised services through facilitating the collaborative working of the specialised commissioning groups (www.ncg.nhs.uk).

The budgets of Primary Care Trusts (PCTs) are top sliced to contribute to this consortium for commissioning specialised services through NSCAG, now through NSCG. The group develops the criteria for defining treatments including emerging treatments, to be classified as specialised services and the service specification and guidelines for delivery of such services. The underlying aims of such commissioning arrangements for specialised services are to ensure that a critical mass of patients can be maintained in each specialist centre. This is to enable the NHS to deliver effective outcomes, maintain clinical competencies, undertake research, sustain the training of specialised staff, ensure the cost effectiveness of provision of such service and for the best use of scarce resources including staff expertise, equipment and donor organs (DH, 1998a; www.ncg.nhs.uk). The changes in structure, however, proposed for the abolition of Strategic Health authorities and PCTs (DH, 2010), do not address the impact of these changes on the commissioning of specialised services or on the development of clinical competencies and knowledge based resources.

6.2.5 NHS costing guidelines

The difficulties of defining costs in health service are recognised and NHS organisations are provided with guidelines for estimation of the cost of health services provided. The estimates of costs thus derived are used in contracts for the commissioning of services within the NHS. Underlying the NHS costing guidelines is the principle of costs established on a full cost basis using full absorption costing, with no planned cross subsidisation between specialities, procedures or contracts. Health economists when adopting a societal perspective use such terms differently in certain economic evaluation studies (Chapter 3, 3.4). As in accountancy (Chapter 3, 3.4.1), to provide consistency in cost data within the NHS, the costing guidelines (DH, 2005a, 2007c, 2008a) define cost terms from an organizational perspective, as follows.

Direct costs are those costs which can be directly attributed to the particular service activity or output being measured (cost centre or product). In a hospital ward, for example the cost of drugs incurred by each ward can be directly attributed to the ward by the pharmacy system. Hence, drugs are a direct cost in the ward cost centre.

Indirect costs are costs of resources which cannot be directly attributed to a cost centre but shared over a number of them. Indirect costs need to be apportioned to the department concerned. There may be no economically feasible method, for example, of identifying linen costs to a particular ward and linen services would therefore become indirect costs of the ward.

The **overhead** costs of a hospital are the costs of support services which contribute to the general running of the hospital but cannot be directly related to the volume or quantity of activity or service provided in individual departments or wards. Such costs could include the costs of planning, personnel, payroll, financial management and the general maintenance of grounds and buildings.

The underlying principles for NHS costing are that the minimum standard for apportionment of indirect costs and overheads are: costs should be allocated directly to a specialty where possible. Further that measures used for apportionment should be readily available, accurately measurable and relate reasonably closely to the cost drivers of the activity. A two-stage apportionment of support services, via patient treatment services to specialty is recommended to accommodate the fact that the structure of the analysis of costs by a department used for management and budgetary control can vary according to each individual provider's management structure. The guidelines recognize that the analysis of cost by type within departments will vary to suit management arrangements of providers. In practice, however, activity data collected is not robust or appropriately detailed enough to enable reliable costing.

The NHS costing guidelines, therefore, recommend the involvement of clinicians, nurses and other professionals, including operational managers, in order that cost allocations are based on an understanding of the activities of service delivery to patients (DH, 2005a, 2007c, 2008a). Furthermore, that resource profiles and the pathway of service delivery used by organisations for costing health services should allow for clinical audit and financial monitoring and form part of internal performance monitoring (DH, 2005a, 2007c, 2008a). The guidelines attempt to provide some consistency in the cost estimations of health services in NHS organisations, to enable comparison of costs. Such guidelines, however, are silent on "knowledge capital" as a resource co-created in the provision of health services. Neither is such a resource recognised within the financial regime used to reimburse NHS organisations for the health service provision.

6.2.6 NHS Charitable Funds Accounting

As discussed in chapter 2, 2.4, what economists call "caring externalities" are created through health service delivery including charitable donations (McPake et al., 2002). In this context, the NHS on its establishment in the 1948 took over a large number of charitable funds that were held by voluntary and local authority hospitals. Such traditions continue with NHS hospitals receiving donations and charitable grants in recognition of services received from the staff and department in the organisation. These funds are maintained as separate charitable accounts for each department or clinical group. Often these funds support projects, research and other expenses for the group that the NHS is not able to support. NHS bodies acting as trustees are responsible for ensuring that the assets of such charities are properly managed in accordance with Trusts and Charity law. These funds amounted to £1.7 billion in 2002 (DH, 2002b).

Charity law stipulates that charities should fund and undertake activities that are for public benefit. They cannot use their resources to provide services that are provided by statute and expected to be financed by rates or taxes. The NHS charities are required to submit two sets of audited accounts every year, one to the Department of Health and the other to the Charities Commission. In terms of external reporting of income and expenditure, the accounting rules governing the accounts of NHS organisations apply to the charities' accounts (DH, 2002b). Trustees of charitable fund are statutorily responsible for producing audited annual accounts. Unlike NHS hospitals, these NHS charities are not constrained by National Treasury rules therefore can carry forward into subsequent years any monies not spent in any one year. This is in line with prudent financial management practice.

6.2.7 Developments in management, finance, accounting and structure of the NHS during the course of the study

During the period of this study there have been a number of developments that affect the management, finance and accounting structures of NHS organisations. The introduction of Foundation Trusts and independent sector treatment centres are changes that impact on the structure of service delivery. In addition, policies such as payment by results (DH, 2002d), practice based commissioning (DH, 2004a) and patient choice (DH, 2006c) and so on, as discussed below, have an impact on the financial regime and financial arrangements for the Department of Health and for NHS organisations.

Payment by Result - PbR

The NHS introduced "payment by results" in April 2004, whereby hospitals base charges for work done on nationally determined average prices for limited clinical specialities subject to cost and volume service level agreements. These prices are derived from the costs of organisations as submitted to the department through reference cost returns (Audit Commission, 2004). The prices or tariffs for each procedure classified by Health Resource Groups (HRGs), a measure of care based on the diagnosis and complexity of treatment. Initially separate tariffs for elective and emergency care was planned and specialised work as defined in section 6.2.4, was not to be included. Service level agreements or contracts between Primary care trusts (PCTs) and NHS Hospital Trusts were based on the cost and volume of activity with payments linked to actual work done. Any reduction or increase in volume was paid for at full tariff rate rather than the additional increase in cost (Audit Commission, 2004).

In year 2004-05 more clinical specialities, including all work commissioned by NHS Foundation Trusts, were to move on to cost and volume agreements. By 2005-06 national tariffs were to be produced for most activities in acute and specialist hospitals. Almost all activity was to be then agreed on a cost and volume basis using the national tariff. The Hospital Trusts were expected to adjust financial arrangements to accommodate fully the tariff by year 2008-09. Hence, all NHS hospitals were being expected to understand and start estimating costs of health services by speciality at hospital level. However, in 2006-07 there were changes to the scope and structure of the national tariff based on the previous year's experience (DH, 2006a) and the timetable was put back. During the study period, HRG 3 was used to support the Department of Health's policy of Payment by Results (PbR), while HRG 4 was introduced in April 2007 which included HRGs for additional clinical areas (DH, 2007c).

The annual national tariff, however, does not recognise that a large proportion of the cost is fixed in the short to medium term whilst prices are to be based on yearly movements of costs and activity. Such a method does not accommodate the impact of organisational constraint in terms of capacity, for example, beds, specialist skills and manpower. The Audit commission (2006) raised the importance of linking data on clinical activity with financial information and the costing system on an ongoing basis in the implementation of the payment by results system. It further identified the defining and costing of specialised services as a significant management issue for PCTs and Hospital Trusts (Audit Commission, 2006) with planning for some specialised emergency services like major trauma or burns as necessary, regardless of demand.

NHS Foundation Trusts

The first of the NHS Foundation trusts were established in April 2004 as independent not for profit public benefits corporations with accountability to local communities (DH, 2005c). Foundation Trusts' income is generated mainly through agreements reached with PCTs to provide clinical services for NHS patients, the training of health service staff and NHS research and development. Additionally, income is generated from contracts with commercial organisations for private health service provision, research and use of NHS facilities. NHS Foundation Trusts can raise capital from both public and private sectors within the borrowing limit agreed with the Department of Health. The NHS Foundation Trust is required to be financially solvent, that is to have sufficient cash flows to pay bills as they become due. This raises the need for NHS Trusts to have a better understanding of their cost base in relation to their activities. Yet within the Foundation Trust regime the hospital could incur deficits overall in the current year and re-invest any surpluses. The Department of Health through the departmental expenditure limit (DEL) accounted for any surpluses or deficits made by Foundation Trusts, though they do not have to break even in any one year.

The level of surpluses and deficits in the financial year 2006 was relatively small as there were only 32 Foundation Trusts (Audit Commission, 2006). The financial regime was developed to ensure that expenditure nationally and within individual organisations matched the funds available within the NHS. The arrangements for financial management were reviewed in 2006 as they were thought to be inadequate to deliver the existing and future needs of the health service in the UK (Audit Commission, 2006). This further highlights the need for better data and understanding of cost of resources used and generated to enable efficient service provision within the health system.

GP Practice Based Commissioning

Changes on the demand side were envisaged by the NHS through the introduction of practice based commissioning (DH, 2004a). In 2005, GP practices were to be encouraged to take responsibility for commissioning secondary and specialised care based on indicative budgets for their practice population (DH, 2004a). The Department of Health, in introducing this policy, expected GP practices to secure a wider range of services responsive to patient needs and provide patients with a choice. In this way, commissioning by GPs is to act as a driver for quality and patient empowerment in health service provision. The PCTs continue to hold the budget and are responsible for service level agreements with providers of health services with the localities making commissioning decisions (DH, 2004b), although there are no robust cost information. The Department of Health is expecting better clinician to clinician dialogue for improving and developing care processes and thereby the costs (DH, 2004b). The National Specialist Services Commissioning Advisory Group's responsibility for financial risk management and funding specialist services was under review. Impacts of such policy changes on the commissioning of health service and research are in focus when studying a specialist service such as pulmonary hypertension.

Patient Level Information and Costing

In the year 2007, the NHS introduced the costing guidelines that required patient level information and costing of services provided at hospital level (DH, 2007c). The costing guidelines are a top down exercise that takes the total cost of the organisation and allocates or apportions at the service level. The changes require a bottom up approach to be included where the inputs for services are identified and the cost built upwards from these wherever possible (DH, 2007c). The NHS envisages that implementing patient-level information costing systems will enable reporting of service level costs with the ability to measure the resources consumed by individual patients. Such changes are in line with expectations that clinicians accept responsibility for the resource implications of clinical activity and involvement in financial decisions. From a reporting perspective, more data about the nature of individual patient care is required to improve the unit of measure for activity, which is used for the HRG classification. HRGs based on adult cardiac care, for example, do not distinguish the high costs of after care for heart transplant patients. The Department of Health regards such detailed information on cost of service provision at speciality level as crucial for informing resource allocation policies (DH, 2007c).

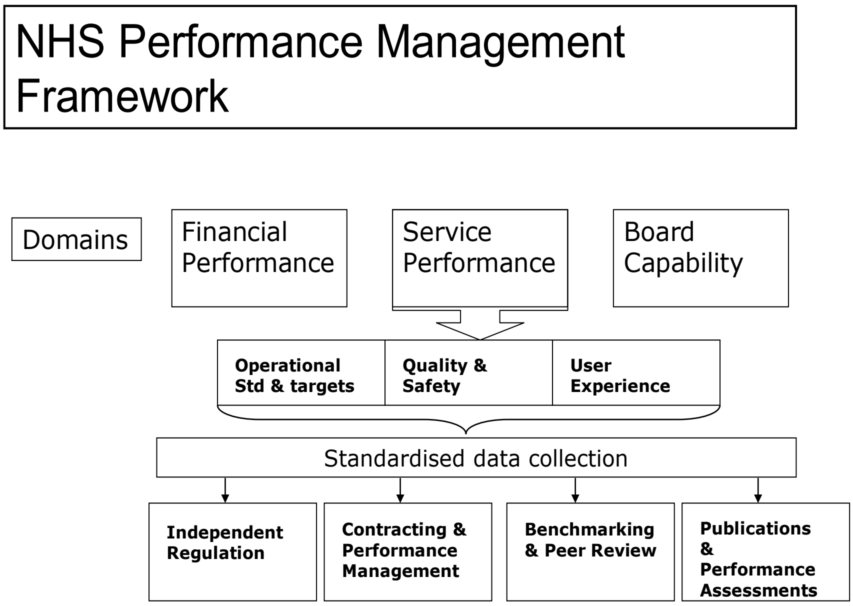
Research & Development

There are also changes in the management, structure and funding arrangements for research and development activities in the NHS. The National Institute of Health Research (NIHR) has been set up to provide a key mechanism in the NHS through which the Department of Health proposes to deliver its R&D strategy set out in 'Best Research for Best Health (DH, 2005b). The Government believes that there is scope for creating structures that are more effective in supporting world-class health research in the UK. The research priorities are being aligned more closely with wider health objectives in order to provide a more coherent approach for translating the results of research into economic benefit. Whilst the stated aim is to embed research in service delivery, such changes appear to add distance between health knowledge creation and clinical practice, which does not bode well for implementation of knowledge generated. Furthermore, the interdependency of the generation of "knowledge capital" in health and health service delivery is not recognised or acknowledged by the changes in policy.

Performance Management

The Department of Health in 2008 introduced a framework (Figure 6.1) to manage performance of health service organisations in the UK with finance, quality, operational, and research as domains. This new framework (Figure 6.1) aims to bring all previous financial, operational and quality standards together into three domains and explicitly includes organisational management capability as an aspect for monitoring. The Department of Health annually reviews the performance of organisations on the three domains and Trust Boards held responsible for performance. An objective of this new framework (Figure 5.2) is to make transparent the basis on which performance in the NHS is measured and the standards organisations are expected to meet.

Figure 6.1 – NHS Performance Management Framework



Source: Developing the NHS Performance Regime
-Department of Health 2008

As indicated in Figure 6.1, the service performance domain is where clinical service provision is measured against set operational standards and targets, monitors quality and safety records and user experience through satisfaction and complaints records. NHS Trusts that provide research, training and other specialist activities are included within the framework, with separate targets and standards for the other additional aspects of service delivery and research.

Such data is used by the Department of Health regulators, such as Monitor (the regulatory body for Foundation Trusts), and the Health Commission (replaced by Quality Care Commission in April 2009), for monitoring service contracts and NHS organisation's performance. Research or new knowledge generation is monitored partly through the numbers and impact factor of publications to indicate quality of research (DH, 2008b). The Department of Health, therefore, continues to require that all NHS organisations collect data on pre-defined performance areas in a standardised form. This standardised data lends itself to benchmarking of service activities through peer review.

The services managed within the framework include health services delivery, training of staff and R&D. The performance framework, therefore, in effect is addressing the various dimensions of "knowledge capital" in health such as "human capital", "reputational capital", "public goods in health capital" and "capacity in health" when it monitors operational standards, quality and safety, user experiences and Board capability. These component parts, however, are not seen as the parts of "knowledge capital" in health and neither is the interdependency of these parts in the provision of safe health services recognised.

In terms of monitoring quality of service provision, there is an increased emphasis on involving patients and capturing their experience as a marker for quality of service provision (DH, 2006c, 2008b). The report ‘Patient and Public Experience of the NHS” (Leatherman and Sutherland, 2007) resonates with this aim indicating that availability of information and involvement in decision making about care is the top most priority for patients. Despite such aims, the crucial nature of having a shared vision with patients for developments in service practice (Clarke and Wilcockson, 2002) and role of patients in knowledge generation is not adequately understood (Nicolini et al., 2008). The NHS therefore, should place high priority on communication, patient-professional interactions and in treating patients as individuals to create a “patient centred" service (Leatherman and Sutherland, 2007).

6.3. Summary

Summarising, the organisations within the NHS face an ever changing business environment and accountability structures. Consequently, NHS organisations require robust data on resource usage and costs together with outputs generated. In setting up Foundation Trusts (DH, 2002c) there is recognition that "public benefits" are derived from NHS hospitals. Whilst the component parts of "knowledge capital" are monitored disparately, in the performance framework none of the changes in the NHS recognise the joint production of health services and "knowledge capital". Furthermore, the financial regime does not recognise such joint production because of the separate reimbursement regimes for service delivery, research and skills development. The guidelines for allocating cost, however, implicitly recognise the difficulty in separating inputs for the various services provided, by recommending clinical team input in such exercises (DH, 2005a, 2007c, 2008a). The NHS management structure and arrangements, nevertheless, can create an artificial distance between "knowledge creation" in health and clinical practice by not recognising the interdependency of service provision and "knowledge capital" generation.

The specialist hospital as a research oriented organisation lends itself to understanding processes and resources used for service provision and "knowledge capital" generation. The transfer of new knowledge and skills and its use in the wider health system that derives from improved understanding of the disease can be visible. The disaggregation of resources used for service provision and generation of new knowledge, skills and interventions, thereby, is made feasible by engaging service providers in such an exercise.

The next chapter details and discusses the findings of the case study of PH services at Papworth hospital derived using the methods described above.

Chapter 7 Results: Case study of PH services at Papworth Hospital

7.1. Introduction

The purpose of this chapter is to present the findings from the case study of the delivery of PH specialised services at Papworth hospital in answering questions of the nature and measurement of "knowledge capital" in health services. The models of "knowledge creation cycle in health" and "dimensions of knowledge capital in health" developed in section I (Chapter 4, 4.3, 4.5) provided a structure in this case study for the exploration and identification of the inputs and processes for the co-production of PH specialised services and "knowledge capital". The difficulties in measuring this resource as an output (Chapter 2, 2.5), were addressed in part, as tackled by economists and accountants, by using the method of measuring outputs through pricing of the inputs of production as a minimum value (Drummond et al., 2005; Drury, 2006).

Phase I of this study highlighted the multifunctional perspectives of knowledge creation (section 7.2.4), and categorised the tacit and explicit types of knowledge generated in health (section 7.2.5). Next, with the engagement of clinical staff, "currencies" or units of measure (section 7.3.1) for activities related to PH specialised services provision were developed. The total cost of PH specialised services provision at Papworth hospital, inclusive of patient care, knowledge creation and service development, was estimated (section 7.4). A minimum value of costs related to "knowledge capital" generation within PH service provision was derived (section 7.7.1). Phase II of the study established the level and nature of investment made from PH team charitable funds towards generating the different overlapping dimensions, namely "human resource", "capacity in health", "tangible", "relational" and "public goods in health", of "knowledge capital" of Papworth hospital's PH team. These funds are interpreted as a monetary measure of the return on the stock of "knowledge capital" generated by the team as these funds are provided on the understanding that the core health service is funded by the NHS and the reputation of the organisation for competency in delivering such services (McPake et al., 2002). Monetary estimates of the stock of "knowledge capital" of the PH team and Papworth hospital were derived using principles of capital assets pricing methods (Chapter 2, 2.5). Some potential non-monetary metrics for measuring “knowledge capital” in health are highlighted.

The findings of Phase I and II of this study are further detailed below. Some implications, for provider and commissioner policies in the NHS health system, by the definition and measurement of "knowledge capital" in health as derived in this study, are discussed in chapter 8.

7.2. Phase I: Qualitative analysis using the "knowledge creation cycle in health" model

In Phase I, analysis of qualitative data (Chapter 5, 5.6.3) helped identify, map processes and resources used as inputs for the joint production of specialised clinical services, knowledge creation and service development for PH services at Papworth hospital. The model of “knowledge creation cycle in health”, developed in section I (Chapter 4, 4.5) provided a structure for the analysis of how knowledge resources were created, shared and used in the provision of PH services at Papworth hospital. Analyses of data from interviews, observation and management reports helped to identify and analyse the objectives, beliefs, processes and resource use of the PH team as service providers. This created a picture of the multi-functional perspectives of knowledge creation in health service provision , and highlighted the knowledge creation cycle in PH service provision at Papworth hospital. Such analysis provided the insights that informed the disaggregation and allocation, to the extent possible, of the resources used for patient care related service provision, knowledge creation and service development. The patient pathway, activity and resource profiles for the joint delivery of PH specialised services and generation of new knowledge and services at Papworth hospital were produced.

7.2.1 Service planning meeting of the PH team

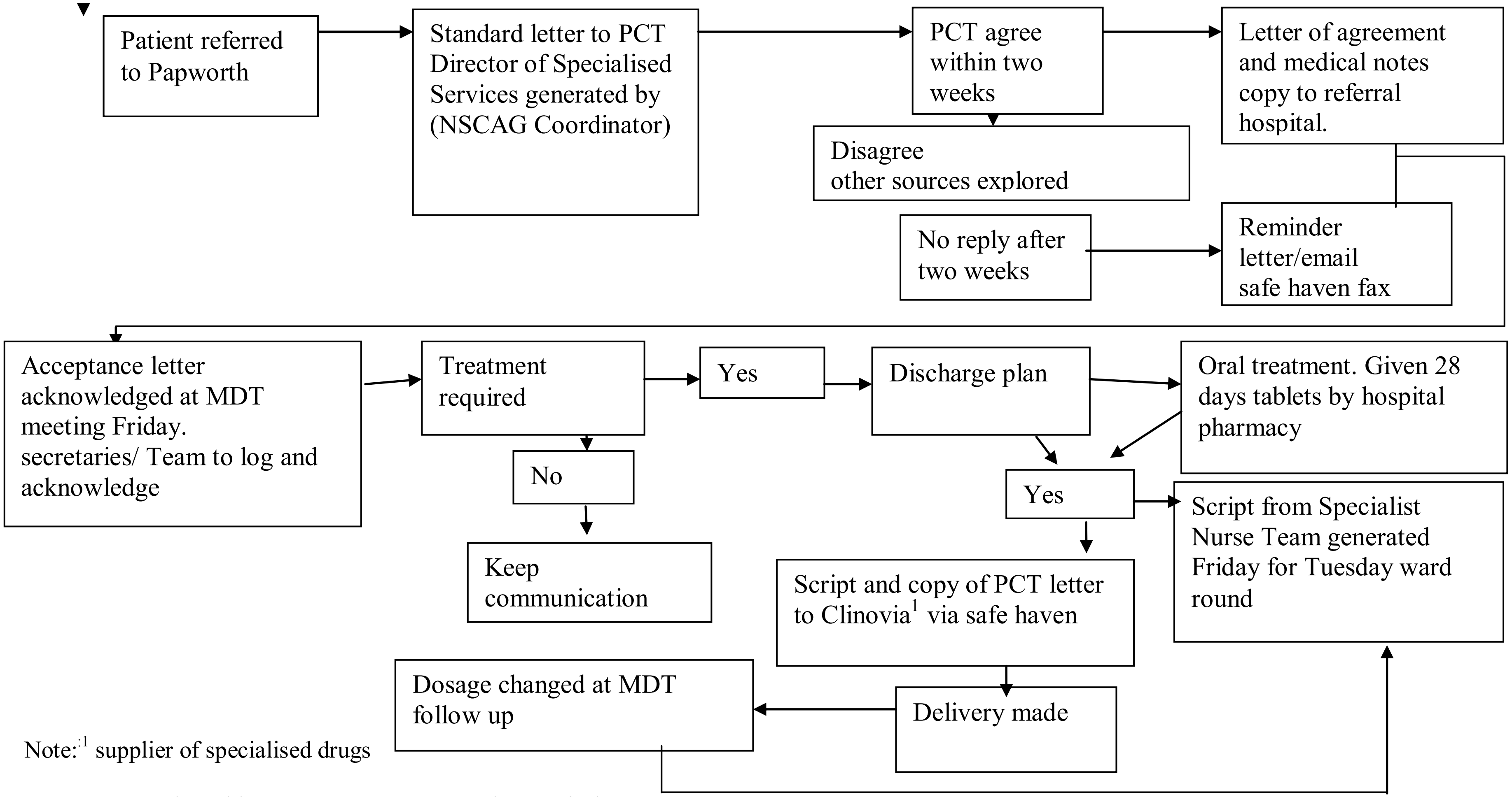
At the time of this study, serendipitously, an operational planning meeting of the PH services administrative and clinical staff was organised by the service manager of specialised services at Papworth hospital. One aim of that meeting, as observed, was to share within the operational team the tasks and processes undertaken by each member. Each member of staff listed their tasks, problems and the timescale available for undertaking those tasks. The meeting acted as a forum where challenges faced by each team member in the existing delivery processes were discussed. Some of the issues raised appeared to be resolved immediately, with members agreeing alternative processes to facilitate a better flow of communication and information within the team.

This exercise where the PH team took time out from actual service delivery, when seen through the model "knowledge creation in health", resembles what Nonaka and Takeuchi

(1995) called the "socialisation" mode. Such a process enabled the team to engage in collective problem solving. The team appeared to be able to share and reflect individually and collectively on their experiences and knowledge of PH service delivery. Observation of this meeting made visible the benefits of a shared context for problem solving and the value to the organisation created by the sharing of knowledge, in both tangible and intangible forms.

A tangible output of this team exercise was the patient pathway (Figure 7.1), the flow of information related to this pathway captures tacit and explicit knowledge into conceptual and systemic knowledge as discussed further in section 7.2.5. This exercise subsequently became part of the routine of operational planning thus embedding experiential knowledge into routine knowledge. The ownership of solutions by the team led to improved service delivery processes being adopted (Newell et al., 2003; Newell et al., 2009; Chapter 2, 2.3) within the hospital. This is an example of the development of skills, improved processes and services in the hospital with the process knowledge accessible to the wider health system as "public goods in health"(Chapter 4, 4.3), which is explored further in phase II of this study (section 7.6, 7.7).

Figure 7.1 Patient Pathway for PH services at Papworth



Note:[1] supplier of specialised drugs

Source: Developed by PH Team at Papworth Hospital

As a result of the entire team's involvement in producing the patient pathway (Figure 7.1) it was understood and accepted by the PH team as a framework for daily routines in delivery of the service. This resonates with Newell et al.'s (2003) findings that best practice was implemented when those implementing the findings were involved in its generation. The sharing of experiences by the team members in the service planning meeting led to non-clinical staff gaining a better understanding of issues related to the clinical condition. Administrative staff felt that such understanding meant that when patients called, as the first point of contact they were able to respond in a manner that was helpful to the patient and thus contributed to improved service provision. Such team engagement appeared to translate into improved skills, knowledge and service provision. There however exists a danger of administrative staff misjudging the scope of their knowledge, or showing over enthusiasm in sharing patient's information, which could potentially create some misunderstandings and confusion. There did not appear to be any mechanism within the organisational routines to systematically manage such a risk, other than regular staff appraisal processes.

Observation of this process nevertheless suggest that this meeting enabled the team to agree and share the common objective of providing improved services for the patient within the constraints of clinical staff time and organisational schedules. A significant benefit observed from the team exercise was the reinforcement for team members that their individual work, both clinical and non-clinical, was contributing to the greater purpose of patient care. This was evidenced by the suggestions put forward, from both clinical and administrative staff, to support clinical routines and administrative processes. The team's relationships within the organisation appeared to be enhanced by the shared experiences of problem solving, information on sources of data used by other departments that could be applied in PH services provision. The greater objective of improving the services provided, meant that staff appeared to access resources not only within the organisation but engaged beyond the organisation through staff and educational networks. As an outcome of this meeting, the team identified available sources of outside information, such as their professional networks, other organisations providing PH services, and internet sources. The PH specialist nurse, for example, agreed to explore and report back to the team on how other PH centres in the UK and the United States dealt with their increases in patient numbers. This was in order to learn from the experiences of others in their field. The intrinsic motivation interpreted as emerging from this process was the creation of a team spirit and a sense of ownership of the knowledge gained. This experiential knowledge (Chapter 4, 4.3) was used to improve the quality of service provision. For example, the administrative staff contact with PH patients was improved by having a named clinician contact for the day when patients called for advice on the telephone. The impact was the creation of a knowledge spiral (section 7.2.5), which in part enhanced skills, knowledge, processes and systems of the patients, PH team and Papworth hospital systems.

Service planning meetings provided what Nonaka and Takeuchi (1995) call a shared context in which “experiential” knowledge (Chapter 4, 4.3), the knowledge gained from the day-to-day experiences of administrative staff and clinical staff, those directly involved, was captured into systems and routines (Appendix 6, 8). Such captured knowledge fed the improvements in the processes of service provision at the hospital as “conceptual” and “systemic” knowledge (Chapter 4, 4.3). Additionally, when all members of the team had their perspectives taken into consideration and were engaged in improving the service delivery process their skills and understanding improved thereby improving the "human capital" component of "knowledge capital".

The patient activity data derived from the "Patient Activity System" (PAS) and PH research data base are other examples of systemic knowledge creation (Figure 7.3) and the "public goods in health" component of "knowledge capital (Chapter 4, 4.5).

The mapping of processes by the team as illustrated in figure 7.1 was labelled "patient pathway" by the team. This map in effect, however, reflects purely the support processes provided by the back office in the delivery of PH services. The patient pathway for clinical processes was understood in this study as described below. This was derived from the guidelines (Appendix 6) developed in the hospital for medical students and new recruits to the team. This is another example of learning from daily business being converted in knowledge based resources.

7.2.2 Patient pathway: Specialised PH services at Papworth Hospital

At Papworth hospital, PH services included an assessment to confirm whether the patient's condition could be diagnosed and classified as PH. On confirming the diagnosis the symptom severity is assessed by using exercise testing through the 6 minute walk test and incremental shuttle test (Gibbs and Higenbottam, 2001; Galie et al., 2004, 2009). Following these tests, the severity of the patient's condition, based on exercise capacity and heamodynamics function, is classified into Class I, II, IIIA or Class IIIB as per the modified New York Heart Association functional classification used by the World Health Organisation (Galie et al., 2004, 2009) as detailed in Appendix 7.

As patients are treated in the hospital (detailed patient pathway in appendix 8), tacit and explicit knowledge of patients and staff was exchanged, generating data that was used for immediate service delivery. Parts of this data such as demographics become information embedded into the routines and systems of the hospital and generalisable as epidemiological data for service planning and developments, which are accessible to the entire health system (NKS, 2005). As these resources are developed within the NHS, they become examples of what are defined in chapter 4 as "public goods in health".

Patients with PH require lifelong monitoring at the specialist centre with appropriate therapies instigated as the disease evolves (Chapter 5, 5.4.1; Appendix 7). Prostacyclin therapy is a drug therapy where costs per patient are high, hence the actual cost of the drugs is funded by the specialised commissioning group. These specialist drug costs are reimbursed to the hospital on a case by case basis. The supply of specialised PH drugs for Papworth hospital patients was provided at home by a sub-contracted commercial specialist supplier and the cost was identified and reimbursed as a distinctly identifiable resource. This study focused on the resources used and generated in the hospital for provision of health services therefore the cost of and revenue from the specialist drug Prostacyclin was not included in the estimations of cost.

7.2.3 PH multidisciplinary team clinical meeting

The PH multidisciplinary clinical team providing the service at Papworth consisted of consultant pulmonary vascular disease physicians, a radiologist, a specialist registrar, a research registrar, the specialist nurse, a post discharge nurse, a palliative care dietician, a physiotherapist, a social worker, the pharmacist, a data coordinator and an audit evaluation support person. The composition of the multidisciplinary team at

Papworth hospital complied with the resource and skills as stipulated by the National Specialised Commissioning Group (Chapter 6, 6.2.4).

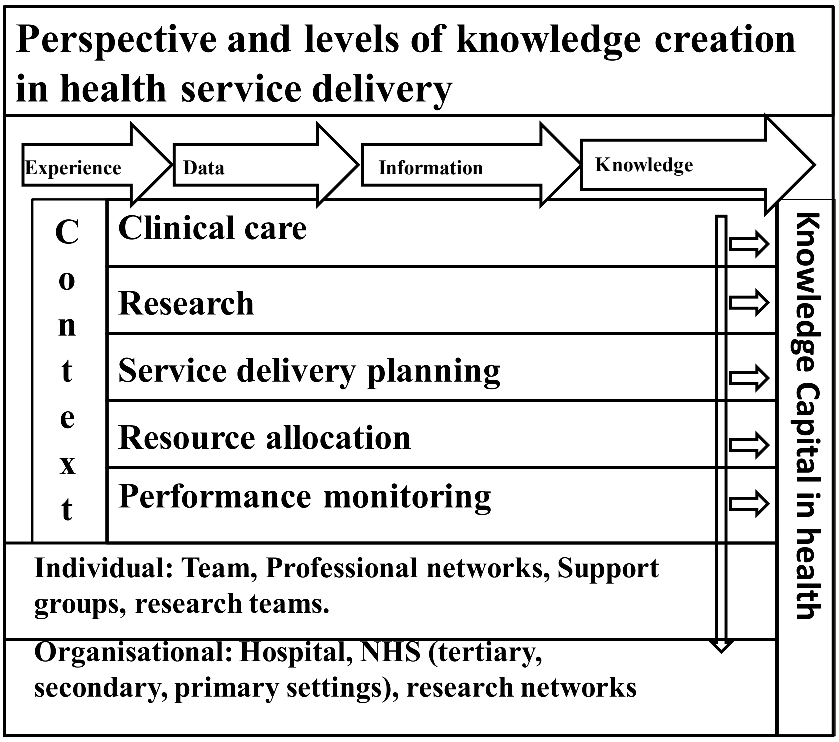
Direct observation of the weekly clinical meeting was similar to the service planning meeting without the administrative staff. The main information and knowledge shared between the members in this meeting were, awareness of the details regarding specific patient on their list, potential ways of resolving issues to improve care for these patients. This meeting serves as another example of a shared context where different clinical disciplinary information and knowledge was shared in order to customise the treatment to particular patients. The team members accessed and shared information from their respective disciplinary and educational networks in trying to find a solution for problems that were identified in particular patients. In some instances, the personal experiences of team members or individual patients acted as a source of information on methods for resolving problems of individual patients that had arisen (observation notes).

Such sharing of knowledge contributed to the creation of new knowledge in health on an ongoing basis for the benefit of individuals and collectively for the organisation (observation notes). Some of this new knowledge contributed to the development of systemic and routine knowledge (Chapter 2, 2.3, Chapter 4, 4.3) both in terms of clinical and delivery processes within the organisation as discussed further in section 7.2.5. The level of input from the diverse specialists within the team was identified, validated, disaggregated, costed and agreed with the team using the format of the management accounting reports. From this exercise emerged an acknowledgement and understanding of the need to use the weekly multidisciplinary clinical meeting effectively to maximise outputs in terms of information and communication (observation notes).

7.2.4 Perspective and levels of knowledge creation in a health service organisation

Analysis of the service planning and multidisciplinary clinical meetings of the PH services team at Papworth indicated that data, information and knowledge created were used in a multifunctional context as illustrated in figure 7.2. Data and information captured in providing service becomes the source data for organisation wide management of operations, resource allocation and performance monitoring. This data then feeds into the national health database which is widely accessible for research and policy making as highlighted by Black (2003) thus adding to the "public goods in health" (Chapter 3, 3.3; Chapter 4, 4.5; section 7.8.1).

Figure 7.2 Multi-functional perspective of knowledge creation in health services



The multiple context of health service delivery as observed at Papworth hospital is illustrated in figure 7.2. In health service provision individual patient's experiences is translated into data. Such data in use becomes information and is transformed into knowledge, some tacit and some explicit, some of which becomes embedded into a hospital's systems and routines. Patient experiences are captured as data in the form of clinical notes and PAS by clinical staff through the socialisation process of admitting the patient into the hospital for treatment (appendix 8). Knowledge gained and captured from such experiences is categorised as experiential knowledge in the NHS (Chapter 4, 4.3; section 7.2.5).

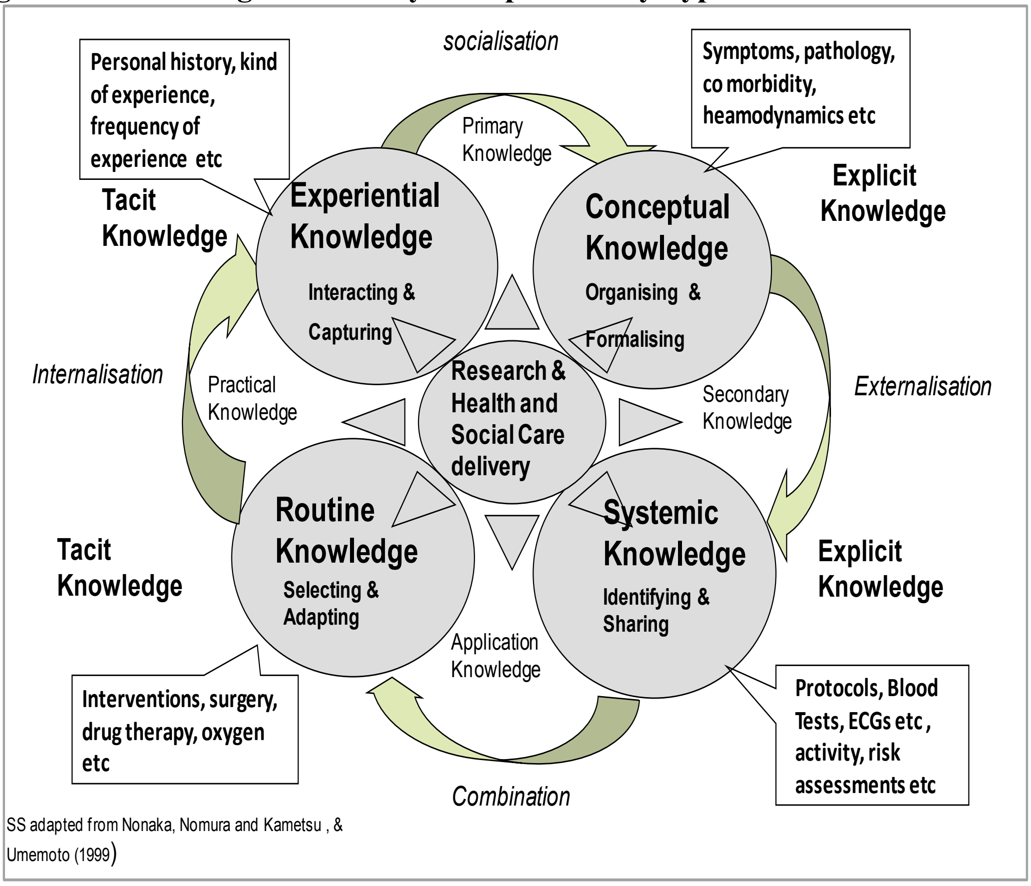
When the organisation's staff organise and formalise this data into symptoms, clinical history, co-morbidities, demographics, and so on, the experiential data becomes information adding to the "conceptual knowledge" of the staff and the organisation (Chapter 4, 4.3, section 7.2.5). Information systems enable the access of this dynamic data by staff in other disciplinary functions such as contract monitoring, finance and so on. In managing the process of billing commissioners (PCTs) and reporting to the NSCAG for services provided, the contract management team in the hospital used the PAS activity data to monitor the actual level of activity in PH services compared to the planned activity, thereby creating "systemic knowledge" (Chapter 4, 4.3, section 7.2.5). The activity information is used to establish and manage the capacity of the team in relation to on call rotas and so forth, which add to the pool of "routine knowledge" at the hospital. The National Specialised Services Group uses the data to monitor performance and advice on further service developments, thereby creating a uniform basis of data collection within the NHS.

The engagement of the wider disciplines in the clinical service provision activities mean that relevant information is likely to be the captured into information systems thereby improving the quality of data used in service provision. In this way the quality of "public goods in health" is potentially enhanced (Chapter 3, 3.3). In the hospital this data, information and knowledge, in addition to direct patient related services and development of processes, skills and knowledge of PH, supports decision making in service planning, resource allocation, performance development and reporting. Such reports produced for management therefore provided a feasible basis for the identification and measurement of "knowledge capital" in PH service provision at Papworth.

7.2.5 "Knowledge creation cycle" in health

Health services are delivered through the transfer of tacit and explicit knowledge between patients and those providing the services. The model "knowledge creation cycle" in health (Chapter 4, 4.5) provided a structure to analyse (Figure 7.3) the nature and generation of knowledge based assets that occur when such transference of tacit and explicit knowledge occurs in the process of delivering specialised health service.

Figure 7.3 Knowledge creation cycle in pulmonary hypertension service delivery



Such analysis categorises the way in which tacit and explicit knowledge is cyclically utilised and embedded into systems and routines that generate "knowledge capital" in health.

Using the model "knowledge creation cycle in health", the experiences of patients are first captured through a face to face interaction when the patient comes to hospital. Data captured is organised and formalised into concepts of history, symptoms and so on. Experiential knowledge can thus be converted into explicit conceptual knowledge for sharing with appropriate colleagues in the organisation to establish diagnosis. The diagnosis of a patient’s condition requires clinical teams to share and combine explicit specialist and systemic knowledge. Such sharing of knowledge supports the identification of diagnostic tests that may be needed and in the interpretation of the results of such tests. Following this the possible health service interventions for a particular patient are identified by clinicians through the combination of experiential, conceptual, systemic and routine knowledge, which may be both tacit and explicit. Possible interventions are shared by the clinical staff with the patient and interventions selected and adapted into routines for the specific patient's circumstance. The risk of the clinician view dominating others, given historical difference in status among the various professional disciplines and the disparity in specialist knowledge, is not visible by the use of this model.

The “knowledge creation cycle in health” (Figure 7.3), nevertheless helps understand the creation and use of what Clarke and Wilcockson (2002), call “proximal knowledge” including tacit knowledge and what national knowledge services call “particular" and "generalisable" knowledge (Chapter 3, 3.3). The model does not, however, provide insight into if and how process knowledge generated is evaluated other than by use.

As highlighted by academics (Newell et al., 2003; Currie et al., 2008) a link between the process of generating knowledge about current health service practice and the transfer of such evidence into practical use was evident (section 7.2.1). Furthermore, when new knowledge required changes in clinical practice, the implementation of change was effective when those implementing it had been directly involved in the knowledge generation (Newell et al., 2003; Currie et al., 2008). Such knowledge generation and change in practice could happen to a lesser or greater degree within different health service organisations. An open access to new knowledge and knowledge based resources generated at Papworth hospital as a specialist centre leads to evaluation and improvement in such resources or "public goods in health" within the NHS (Appendix 6).

In the course of service delivery, data captured in the form of databases and notes form part of the system for capturing and storing information which is used for management purposes such as commissioning, delivering and researching of health service. Such information becomes aspects of “knowledge capital” in health, partly through the processes of capture and partly through the sharing of experiences by users of the information in the course of service provision, for example in team meetings, clinical audits, contracts monitoring and research meetings. During such processes when professionals or researchers are able to link patient specific data to population data, the resultant information becomes useful in the identification of trends in disease patterns such as epidemiological trends.

The data on health trends facilitates the understanding of the epidemiological basis for health conditions and in providing and developing possible solutions (Black, 2003). Furthermore, the cross-referencing of healthcare data with other databases that contain population data acts to improve methodological rigour of research in health (Black, 2003). From an epidemiological and macroeconomic perspective such linkages make some aspects of such health related databases "public goods in health", making them valuable in understanding the history and development of disease, the identification of the causes of disease, the evaluation of health interventions and in assessing the equity and utilisation of care.

The model of "knowledge creation cycle in health" helped analyse and highlight how experiential, conceptual, systemic and routine knowledge are transformed from tacit to explicit in the course of health service provision. The service providers, through a face to face process, capture the patient's health experience. The interaction occurs when the service providers take patient details and clinical history when a patient arrives at the hospital (Appendix 8). In this process, the experiential knowledge of the patient which has been mainly tacit is transformed, in part, into explicit data and information that is accessible by others. The conversion of knowledge from tacit to explicit enables health professionals to use their clinical knowledge that is conceptual knowledge, to organise the data and information into formal concepts such as symptoms, pathological causes, co-morbidities and heamodynamics, thus adding to the knowledge base in those areas. Some of the new knowledge created whilst useful in context, may not always be possible to verify and generalise, which raises dangers of inappropriate use of data. The traditional verification and testing of all knowledge created can be difficult as aspects of such knowledge can be tacit and revealed only in context of use, therefore caution needs to be exercised before systemisation.

Nevertheless, each contact with a patient either results in the generation of new tacit and explicit knowledge or refines the existing knowledge base of the science and processes. Health service delivery can therefore be described as the process of finding solutions for a patient's health condition within a shared context. Each patient contact can also be seen as a means to test for any gaps in the routines and systems in the organisation that delivers health services. New process knowledge, thus generated in the course of service provision and research, becomes tacit knowledge for the individuals involved in the process. Additionally, some parts of such new knowledge become explicit and embedded into the service management processes and systems of the organisation. The embedding of such new process knowledge, for example process flow chart (Figure 7.1), treatment guidelines (Appendix 6) or patient pathways all generated in the course of service provision, adds to different dimensions of "knowledge capital" for the organisation including "public goods in health" (Chapter 3, 3.3).

Through the delivery of health service tacit knowledge transforms into explicit knowledge and when captured into systems and routines create "knowledge capital". Aspects of this resource are accessible for further use by the various disciplines and organisational networks involved within the organisation and wider health system. Delivering specialised health service creates new external professional networks when staff share knowledge gained from service delivery with other professionals outside the organisation. Such free sharing improves the resource through use and raises the reputation of the team. This in turn supports the maintenance and provides further investments in "knowledge capital" as discussed later in this chapter.

This analysis highlights that the "knowledge capital" generated in health service provision includes additional dimensions of "public goods in health" and "capacity in health" as discussed in chapter 4, 4.5. These take the shape of improved competencies for individuals, improved processes and capability for organisations that result in increased national and global capacity for delivering services and research. The emerging nature of the management of PH made more visible the knowledge creation aspects of service provision. Estimates of the cost of resources utilised for service provision, derived by using quantitative analysis based on management accountancy techniques is discussed next.

7.3. Phase I: Quantitative analysis of activity and costed resource profiles

As discussed in chapter 2, 2.5 and chapter 5, a method based on an input pricing approach used by economists and accountants is adopted as the most feasible means of measuring this hard to measure resource. Following the "bottom up" approach of costing (Chapter 5, 5.6.3) the resources used for service provision were identified, quantified, costed and allocated as inputs of the joint production of clinical service, education, knowledge creation and service development. Such estimates formed the basis for deriving a minimum value of "knowledge capital" as a joint output.

The units for measurement of activity that constituted PH specialised services are generated with the PH team (Mays et al., 2005) so as to be meaningful data and useful in service planning. Service activity and financial reports of Papworth hospital were reviewed and used to generate data on the inputs of production of PH services. Based on a management accountancy technique of "bottom up" costing (Chapter 2, 2.5, Chapter 3, 3.6), activity and resource profile templates were generated and agreed with the team. The detailed resource profiles, based on the patient pathway generated by the PH team (section 7.2), provided the basis for estimating the cost of resources used by Papworth hospital for PH service provision.

These resource profiles acted as a framework for a joint accountancy economic approach (Mugford, 1996; Drummond, 2005; Mogyorosy and Smith; 2005; NICE, 2008) to the costing of PH service. A “bottom up approach” made feasible the use of the softer tacit insights of service providers in disentangling and allocating the costs of the resources used between the joint products of PH service, knowledge creation and service development activities. Furthermore, where possible, the resources used for each of the co-products are identified separately using PH team's experiential knowledge. Such an approach provided a practical template and method for involving clinicians in the identification of resources for purposes of costing specific services as recommended by the NHS costing guidelines (Chapter 6, 6.2.5; DH, 2005a, 2007c, 2008a).

All resources including those funded through non-health service sources are included in estimation of costs of resources used for the entire spectrum of PH specialist services. An estimate of "knowledge capital" generated in PH services, as a minimum value in the year, is derived by deducting the cost of routine clinical service provision based on HRG tariffs, from the total cost of its co-production. This estimate, based on available data and knowledge, is the most feasible and makes a start at identification and measurement of this difficult to measure resource in the management of health service.

7.3.1 Activity Profiles

The "currencies" or units of measure derived in discussion with the PH specialised services manager, members of the clinical team delivering the service, and the contracting and financial information staff are detailed in Table 7.1. These measures are based on the treatment location, the stage of treatment, level of resource used and their applicability in operational planning.

Table 7.1: Pulmonary Hypertension Service Activity Profile for year 2005-06

Service Activity (spread evenly through year)	**Attendances**
Assessments	
Assessments Thoracic Day Ward FCEs	62
Assessments Inpatient - FCEs	65
Total Assessments	**127**
Followup	
Follow up - Inpat FCEs	186
Follow up - Thoracic Day Ward Attendances	291
Follow up - outpat - Attendances	303
Total inpatient and outpatient followups	**780**
FCE: Finished consultant episode	

The five units of measure agreed and resource profiles developed are, "assessments thoracic day ward FCE", "assessment inpatient FCE", "follow-up inpatient FCE", "follow-up thoracic day ward attendance", and "follow-up outpatient attendance". These units of measurement encompass the range of components of treatment for this condition, from assessments to the follow up stages of treatment.

Activity data derived from the PH research database was cross-validated for accuracy and reasonableness with the hospital's management accountancy, PAS database, the costing database and contract monitoring database reports. The clustering of activities was based on the available data and knowledge thus making a start in creating units of measurement for this condition in which treatments are still developing.

Estimations of activity were derived based on the team's knowledge of the trends, corroborated with the previous year's activity data and on the number of new patients admitted for assessments each year in the previous years. A forecast of 127 total assessments, 62 attendances at the thoracic day ward and 65 as inpatients was estimated for the year April 2005 to March 2006. The estimates for followup activity were 186 episodes as inpatient, 291 attendances at the thoracic day ward and 303 visits to the outpatient clinic. Follow-up activity is estimated by including the existing patient list minus those expired, plus the new patients' follow up likely in the year. The financial year 2005-2006 is used in this study as the National Specialist Advisory Commissioning Group was reviewing national capacity for the provision of pulmonary thromboendarterectomy (PTE), a surgical intervention for chronic thromboembolic pulmonary hypertension (CTEPH), and the consequential impact on capacity for provision of PH services. Planning for resource use for such growth is a key feature of a condition in which treatments are developing, which makes more visible the use and generation of knowledge based resources.

The reason provided by the team for the capture of activity data in a separate research data base was that the existing PAS could not capture the details required for research or reimbursements of cost due to the emerging nature of the treatment. In Papworth hospital, a local database captures the data required for research studies as numbers of patients with this condition are limited. This research database captures every contact with patients referred for this condition and the investigations undertaken both for treatment and research, serving the PH team's operational requirements. There is a gap between the PAS and the wider NHS system, for developing appropriate classification for PH activity as the management of the condition is emerging at Papworth hospital.

Although a separate database served the PH team, the capture of data in separate databases raises issues of double handling or omission of data when incorporating such data into PAS. Furthermore, there may be a reluctance to merge data collection into main systems with perceived loss of control and job. At Papworth as the activity and treatment developed and activity numbers increased, the data from the research database was used to support the commissioning of this service and the national development of services and specialist skills required for such provision. In this instance, the learning from a system of data capture developed for research informed adaptations to the organisational systems that link to the health system. This in turn converts this data into more widely accessible information and knowledge, thereby adding more rigour to the data (CHIR, 2002). Furthermore, such open accessibility and sharing generates a "public good in health" in the form of data for that is useful for research and health policy (Black, 2003; Chapter 4, 4.5).

The PH activity data from the research database and PAS is analysed using data from interviews and observations and then reconciled to the costing and contract monitoring databases for consistency. This process led to acceptance by the clinical, service planning, contracting and finance team of the resource profiles for PH services at Papworth hospital. The classification derived in this study for measuring PH services was thus accepted as credible by the service delivery team for operational planning and estimation of the costs of this service. The National Specialist Advisory Group accepted this classification of service activity for its contract negotiation, performance reporting and development of national policies for this service.

7.3.2 Resource profile and costing of resources use

The resource profiles developed use Papworth management accounts format in a “bottom up” process (Chapter 6, 6.3) to identify and allocate resources to the five agreed units of activity, namely "assessment inpatients", "assessment thoracic day ward", "follow up inpatients", "follow up thoracic day ward", and "follow up outpatients". The estimated multidisciplinary team cost (Table 7.2) was treated as fixed cost (Chapter 6, 6.3) for the year irrespective of changes in volume of activity, as the staff required does not change within a range of activity. Analysis of financial and costing databases provide the data necessary for the estimation of the costs of resource use, including the unit cost of the tests for costing the resource profiles (Table 7.4, 7.5, 7.6, 7.7, 7.8, 7.9).

7.3.3 PH multidisciplinary team cost

The range, level and costs of the multidisciplinary staff providing PH services at Papworth hospital based on management accountancy reports are detailed in Table 7.2. The PH multidisciplinary team include the range of support specialities required as a minimum by the specialised PH service specification in the NHS (DH, 2003a). This includes radiologists, pathologists, cardiac and lung function technicians, social workers, paramedics, physiotherapists, pharmacy, and palliative care.

Table 7.2 - Cost of Multidisciplinary team - year 2005-06

Multi- Disciplinary Team - Assessment & Followup		Units	**£**
Consultant physician -(2 Wte)	sessions	20	304,200
Specialist Registrar+Research Registrar- Deanery contribution)	wte	3	166,036
Specialist nurse coordinator	wte	1	42,624
Specialist Nurse	wte	1	42,624
Social worker	wte	0.10	4,791
Dietician	wte	0.10	4,791
Physiotherapy	wte	0.10	4,791
Palliativecare	wte	0.50	19,500
Secretary/admin	wte	2.50	61,750
Pharmacy support	wte	0.50	20,800
Radiologist	session	1	15,600
Data coordination &Audit/evaluation	wte	0.50	12,350
Post discharge Nurse	wte	0.50	21,312
Total Cost of Multi- Disciplinary Team - Assessment & Followup			**721,171**

wte: whole time equivalent

The cost of providing the multidisciplinary team at Papworth hospital was estimated at £721,171 per annum (Table 7.2). The salary reimbursements received from the Deanery of medical education for trainee specialist registrars were not included as a cost of PH services. This cost is partly reimbursed for the development of specialist medical staff education, separate from the funding for provision of health services. This multidisciplinary team (Table 7.2) provided both assessment and follow-up components of PH services. The range of disciplinary specialists included in the team reflects the fact that treatments in this condition are emerging. This spread and level of staff resources are required as a minimum when providing specialist PH services irrespective of volume of activity (Chapter 5, 5.4). This cost is therefore in accounting terms treated as a fixed cost, as discussed in chapter 6, 6.3.

The Department of Health (2003a) PH service specification mandates that appropriately trained specialised medical and nursing staff are available on call twenty-four hours a day to ensure prompt medical attention as emergencies arise.

Appropriately, there were two consultant vascular disease physicians (Table 7.2) in the team so that specialist physician care was available on a twenty-four hour basis. Papworth hospital as an accredited post graduate teaching centre within the NHS included, a part funded, specialist trainee registrar within the PH team. The multidisciplinary team cost of £721,171 (Table 7.2) reflects the additional costs of the specialist registrar not reimbursed by the Deanery. At least 50 percent of their time is utilised for research or in providing service cover for those colleagues engaged in research.

Papworth hospital, employment contracts set aside a proportion of staff's contracted time for research, and skills and service development activities. There is no sure way currently to measure the value of knowledge inputs or knowledge outputs of service provision. Nevertheless, as staff time is contractually allocated for research and development activities, such costs were used as an estimate of the cost of knowledge inputs, as a minimum and detailed in table 7.3.

Table 7.3: Research time as a percentage of "human capital" cost in PH services

Staff	**Yearly Cost**	**Annual**	**Time**
	£	**£**	
Consultants	304,200	60,840	20%
Specialist Registrar + Research Registrar	166,036	83,018	50%
Specialist Nurse Coordinator + Nurse	85,248	42,624	50%
Other Professionals	153,337	7,667	5%
Data Coordinator & Audit	12,350	7,410	60%
Total Investment	**721,171**	**201,559**	**28%**

Of the total staff costs, 28% (Table 7.3) relates to staff time explicitly allocated by the organisation for purposes other than direct patient care that is development of knowledge, skills and services. The numbers of PH patients at the hospital were large enough to require other professional and administrative staff to support research related activities which account for 60% of staff cost. These activities included the development of IT systems such as databases and guidelines in the developing treatments for this condition. In addition, some administrative support was provided from the hospital's central management and reflected as an overhead element of staff cost.

In practical terms, this study observed that the activities of service delivery and research are interdependent and undertaken as required by all team members. The costs of PH staff time set aside for such activities that help maintain and generate the skills and competencies of staff and were therefore interpreted as investment in the "human capital" element of "knowledge capital" (Chapter 4, 4.5). Investments in human capital were estimated at £201,559 per annum discussed further in section 7.5. The Charitable funds generated by Papworth hospital from undertaking research and fund raising activities are, discussed further in section 7.7 (Table 7.14). Analysis of such funds highlighted the funds raised from research, patient goodwill, educational and knowledge transfer activities of the PH team.

7.3.4 Costed resource profiles: "assessments inpatient episodes" & "day ward attendances" 2005-06

The multidisciplinary team start the assessment of patients with a review of diagnostic test results forwarded from the referring centre. Further tests, as required, were undertaken to confirm the diagnosis and establish clinical class and severity of their condition (Chapter 5, 5.4). Assessments were undertaken on the thoracic day ward with patients using a bed for the day while the various tests and procedures are undertaken. When the patient’s condition or the location of their home requires a longer stay in hospital, they were admitted as an inpatient.

The length of stay at Papworth hospital for an inpatient assessment ranges from 3-7 days and the average length of stay for inpatient assessment was estimated at 5 days based on the average length of stay data of PH patients. Depending on the severity of the condition and the distance of travel to the hospital from their home, patients undergo investigations over two sets of inpatient stays. Both stays were included as a single composite episode for the average length of stay calculations. Patients stay longer when started on further complicated therapy therefore for such incidents the extra bed days tariff were included in the costs.

The list of resources used for the assessments as a thoracic day ward attendance and inpatient FCEs are detailed in Table 7.4 and 7.5.

Table 7.4: Variable cost of resource profile for "assessments on day ward"

Resource Profile Assessment - Thoracic Day ward		**per unit**	**Total**
Thoracic day ward FCEs	*62*	£	£
Echocardiogram		77	4,766
Echocardiogram - Bubble Study		4	238
Bloods		19	1,175
Anti body screening		300	18,600
Thrombophilia test		42	2,579
Thyroid test		5	322
Pro B-type Natriuretic Peptide test		50	3,100
Pulmonary function test (PFT)		26	1,632
6min Walk		17	1,054
Chest x-ray		19	1,178
Ventilation Perfusion - lung scan		58	3,623
High resolution Computed Tomography- angio scan		111	6,855
Ward costs (Thoracic ward beddays)		356	22,067
Total Variable Cost Assessment - Thoracic Day ward Episodes (FCEs)	**62**	**1,084**	**67,189**

Table 7.5: Variable cost of resource profile for "assessments as inpatient"

Resource Profile - Assessment - Inpatient		**per unit**	**Total**
Inpatient episodes	*65*	£	£
Echocardiogram		77	4,996
Bloods		19	1,232
Anti body screening		146	9,506
Thrombophilia test		42	2,704
Thyroid test		5	338
Pro B-type Natriuretic Peptide test		50	3,250
Pulmonary function test (PFT)		26	1,711
6min Walk		17	1,105
Chest x-ray		19	1,235
Ventilation Perfusion - V/Q lung scan		58	3,799
High resolution Computed Tomography- angio scan		111	7,187
Invasive cardiology - RH Cath		737	47,905
Pulmonary angiogram		327	21,255
Non Molecular Heparin _ Clexane		100	6,500
Magnetic Resonance Imaging scan		391	25,393
Ward costs (Thoracic ward)		1,725	112,109
Hickman line, Long Line, Nebulisers		400	26,025
Total Variable Cost Assessment - Inpatient	**65**	**4,250**	**276,250**

Assessments of patients admitted either as a thoracic day ward attendance or as an inpatient require blood investigations for anti-body screening, thrombophilia, lung function, thyroid tests and scans. The conditions of patients admitted as inpatients were generally more severe and required invasive investigations, such as right heart catheter, pulmonary angiogram and magnetic resonance imaging (MRI). Generally, these patients required the insertion of an intravenous line called a "Hickman line" for the administration of intravenous therapies as necessary. Invasive cardiology investigations like right heart catheter required ready access to cardiology and a cardiac specialist in case of emergencies during the procedure. As Papworth hospital, specialises in services relating to heart and lung conditions the PH team when they undertake such invasive investigations have instant access to such emergency support if needed. The cost of the cardiologist time inputs were not included in the cost of the service as such input was seen as part of emergency care and not allocated to PH services.

The staff input in terms of understanding the patient needs with this condition and educating them underlies the service delivery processes. The cost of the multidisciplinary team required was treated as an annual fixed cost and allocated across assessment and follow-up activities. This disaggregation based on planned level of activity as perceived by the PH team is detailed in Table 7.6 and Table 7.7.

Table 7.6: Summary Cost of Assessments including staff cost

Assessments summary of costs	**Activity - nos**	**Cost per unit**	**Cost Total**
		£	£
Thoracic Day ward Assessments Table 7.4	62	1,084	67,189
Inpatient Assessments - Table 7.5	65	4,250	276,250
Total Variable Cost - Follow up	**127**		**343,439**
49% of multidisciplinary staff cost -Table 7.2			**352,068**
Total Cost - Assessments	**254**		**695,507**

Based on the team's experience 49 percent of their time was estimated as spent on assessments of patients in the day ward and as inpatients with the remaining 51 percent on follow-ups. The total staff cost of £721k (Table 7.2), therefore was allocated to costs of assessment activities at £352k (Table7.6) and to the costs of follow-up activities at £369k (Table7.10), to reflect the level of time staff perceived to spend on these activities. An increase in volume of activity was reasonably forecast as more patients were likely to be referred, diagnosed and followed up with developments in the knowledge base of the condition. Such increase in activity will require a stepped increase in staff capacity and an increase in cost or a more "efficient" provision of service by existing staff.

The variable costs of an assessment included the cost of diagnostic tests undertaken and usage of a ward bed. The costs of tests were derived from reports produced from the costing database used in the hospital. The estimation of the cost of such tests was based on the cost to the hospital of providing the tests including a share of the organisational overheads. In instances where the tests were carried out internally by another department such as MRI or CT scan, the prices used to charge external customers for such tests were applied as the opportunity cost. The total variable costs of an assessment provided as a day ward attendance was estimated at £1,084 (Table 7.4) and £4,250 (Table7.5) when provided as an inpatient episode. The main difference in costs between day ward attendance and an inpatient episode is the additional cost of extra bed days used, and the provision of more invasive tests and procedures.

7.3.5 Follow ups (costed for year 2005-06)

In accordance with nationally agreed protocol (Chapter 5, 5.4) the schedule for patient follow-up visits after assessment was organised at 6 weeks, 3 months, 6 months, and 9 months after treatment visit. The average length of a follow-up visit ranges from a day to 7 days depending on the range and kinds of procedure and tests carried out. The follow-up attendances can be as an outpatient visit, or as a thoracic day ward attendance or as an inpatient stay depending on the clinical need of the patient, the severity of the patient's condition and travel distance for the patient. In addition, the team provided support to patients on the telephone in between visits to the hospital. This was an additional reason for allocating staff time at the aggregated level of activity rather than per unit of activity or per patient. The detailed estimates of the cost of resources used for a follow-up as outpatient, in thoracic day ward and as inpatient, are listed in Tables 7.7, 7.8, 7.9, 7.10.

Table 7.7: PH Thoracic Day ward Followup variable costs

Thoracic Day Ward - Followup	£
Ventilation Perfusion - V/Q lung scan (one in ten patients)	23
High resolution Computed Tomography- angio scan	110
Bloods	19
Pro B-type Natriuretic Peptide test	50
Right Heart Catheter	213
Non Molecular Heparin	50
Chest X Ray	19
Echo	77
6" walk	17
Multigated acquisition Scan (MUGA/MIBI)	57
Magnetic Resonance Imaging (MRI)scan	391
Day bed	356
Thoracic Day Ward Followup	**1,381**

Table 7.8: PH Inpatient Followup variable costs

Inpatient Followup	£
Ventilation Perfusion - V/Q lung scan	237
High resolution Computed Tomography- angio scan	110
Bloods	19
Pro B-type Natriuretic Peptide test	50
Right Heart Catheter	737
Non Molecular Heparin	105
Chest X Ray	19
Echo	77
6" walk	17
Multigated acquisition Scan (MUGA/MIBI)-7in 10 patients	40
Magnetic Resonance Imaging (MRI)scan	391
Hickman Line insertion	300
Long Line	100
Bed Days - 7.27days	2,589
Inpatient Followup episode	**4,791**

Table 7.9: PH outpatients Followup variable costs

Out patient Follow up	£
Pulmonary function test (PFT)	26
Bloods	19
Pro B-type Natriuretic Peptide test	50
Chest X Ray	32
6" walk	17
Out patient Follow up attendance	**144**

As shown in tables 7.7, 7.8 and 7.9, the costs of providing follow up as an inpatient and in the day ward are higher than as an outpatient due to the use of a ward bed for the stay in hospital. Among the follow up attendance in the thoracic day ward and the inpatient follow-ups, 50 percent require the expensive procedure of invasive right heart catheterisation (Table 7.10) with emergency care cover consistent with that of treating a progressive condition (Appendix 7). The average length of stay is 7.27 days for follow-ups as an inpatient. The longer stay required more specialist resources and care, as patients worsen with the progression of the condition (Chapter 5, 5.4; Appendix 7).

Table 7.10 PH follow-up visits Summary of costs

Resource Profiles - Follow-up		**Cost per unit**	**Cost Total**
	Activity - nos	£	£
Out Patient - Follow up Table 7.9	303	144	43,546
Thoracic Day ward Follow up- Table 7.7	291	1,382	402,087
Inpat Followup Table 7.8	186	4,791	891,054
Total Variable Cost - Follow up	**780**	**1,714**	**1,336,687**
51% of multidisciplinary staff cost - Table 7.2			**369,103**
Total Cost of Follow-ups			**1,705,791**

In summary, the variable cost of a follow-up visit as an outpatient attendance at £144 was much lower than the variable cost of £1,382 as a thoracic day ward attendance, and of £4,791 as an inpatient (Table 7.10). This was because relatively stable patients requiring routine tests were seen in outpatient clinics whereas patients whose conditions had progressed required invasive investigation and were treated on the thoracic day ward. When patients live at close proximity to Papworth hospital, their clinical condition permitting and at their request, they came in as day ward patients over a number of consecutive days. In such instances, the consecutive days on the thoracic ward were accounted for as an inpatient episode and excluded from thoracic day ward figures. However, when a patient's condition required greater clinical monitoring, follow up was undertaken only as an inpatient. All patients required staff telephone support and advice on an ongoing basis between visits. This resource use was reflected in the staff resource allocated to follow-up activities.

The greater proportion was allocated to "follow up" as the team found that PH patients became progressively more ill and required greater support and input during their contact with the hospital. In addition, the team provided advice to clinicians at secondary hospitals and GPs when these patients were receiving treatments for other conditions. The cost of tests and ward days were accounted as variable costs as they were linked to the number of these activities undertaken.

7.4. Estimates of the cost of PH service provision

Two main components to the clinical care aspects of PH service provision was identified and agreed with the team, namely initial "assessments" and "follow up". These units of measurements derived based on severity and resource usage meant the disaggregation of the joint resource use was meaningful from a service planning perspective.

These cost estimates derived using an accountancy method gives a point estimate of the unit cost of assessments and follow-up visits, but does not convey the range or distribution of costs per patient. The of the total cost of service provision including the cost of the multidisciplinary team, and the variable costs estimated, together with the accounting nature of these costs are detailed in table 7.12.

Table 7.12: Pulmonary Hypertension - Costed Resource profile (2005-2006)

Papworth Hospital Pulmonary Hypertension - costed resource profile						
Year 2005-06				**Total cost**	**Nature of Cost**	
	Activity nos	**cost per**	£	**£**		
Total Cost of Multi- Disciplinary Team - Assessment & Followup				**721,171**	**Fixed cost**	line 1
Total Variable Cost Assessment - Thoracic Day ward Attendances	62	**1,084**	67,189			line 2
Total Variable Cost Assessment - Inpatient FCEs	65	**4,250**	276,250		**Variable cost- Assessments**	line 3
Total Assessment cost(inpat and Outpat)/unit costs(in staff cost)	127			**695,507**	**Assessment Fixed + Variable cost**	line 4 = line 2 + line 3 + 0.49*line 1
Total Variable Cost - Follow up	780		**1,336,687**		**Variable Cost - follow up**	line 5
Total Followup cost/ unit cost- inc staff cost	780			**1,705,791**	**Follow up fixed + variable cost**	line 5 + (0.51* line1)
Total (inc central/overhead costs) excluding PH drug cost				**2,401,298**	**Total cost excluding drug cost**	line 7 = line 4 + line 6
Total Pulmonary Hypertension Services, Income Plan 05-06				**1,675,625**	**Reimbursed on PBR tariff**	
			Shortfall ?	**725,673**	**Knowledge Capital ?**	

Resources used for the multiple components of service provision and knowledge creation were difficult to separate, measure and allocate to the various categories of activity. Particularly the knowledge inputs of staff and patients accumulated over time and the related costs that are joint and often inseparable (section 7.3). These estimates thus reflect the cost of such knowledge inputs at a minimum value. Additionally, the knowledge of the PH team on the resource used for service provision made the difficult allocation of costs between joint products (Drummond, 2005) within its context of use feasible. Furthermore, as Mays et al. (2005) suggest evidence is derived through a narrative synthesis, based on qualitative and quantitative findings that policy makers increasingly require. Based on data that was feasible to collect and using accountancy methods the total cost of providing PH specialised services and research, excluding PH drugs such as prostacyclin, was estimated at £2.4m.

The reimbursements for provision of the patient care aspect of specialised PH services are paid for by PCTs through NHS specialist commissioning groups agreed contracts. The PH specialised services contract value was used to separate costs of clinical service provision and other knowledge outputs. The contracts for clinical services are based on activity as measured in terms of HRGs relevant for PH as discussed in section 7.4.1. Although not part of the main Payment by Result regime, the contract for PH services was informed by HRG tariffs, and other payments for above average bed usage.

7.4.1 Healthcare resource group (HRG) tariffs for PH services (year 2005-2006).

The HRG tariffs as applicable to contract for provision of PH services at Papworth hospital and in use for the year 2005-06 are listed in table 7.13 In. the year 2005-06 a variety of HRG tariffs were applicable for PH clinical service reimbursements (Table 7.12), which relate to a general group of other cardiac conditions or unclassified cardiac illnesses. These HRG classifications or tariffs do not reveal the resource profiles for these classifications thus the differences in resource use and costs between different HRGs are not easily comparable.

Table 7.12: HRG tariffs used for PH Services provided at Papworth Hospital - financial year 2005-06

Papworth Hospital - NHS HRG tariff used for Pulmonary Hypertension - financial year 2005-2006			
D06	minor thoracic conditions requiring <2days stay),	Day case	£568
		Elective	£568
		Non Elective	£633
D07	Fibre optic Bronchoscopy (requiring <2 days stay)	Day case	£504
		Elective	£504
		Non Elective	£624
E14	Cardiac Catheter and angiography without complications and co-morbidities	Day case	£956
		Elective	£956
		Non Elective	£2,816
E37	other Cardiac Diagnoses (ranging from viral carditis to haemorrhage, not elsewhere captured)	Day case	£1,234
		Elective	£1,234
		Non Elective	£2,421
E38	Electrophysiology and other Percutaneous Cardiac Procedures>18	Day case	£2,278
		Elective	£2,278
		Non Elective	£3,801
E39	Electrophysiology and other Percutaneous Cardiac Procedures>19	Day case	£2,456
		Elective	£2,456
		Non Elective	£3,675
E40	Other Cardiothoracic or Circulatory procedures >18	Day case	£1,392
		Elective	£2,456
		Non Elective	£3,675
E41	Other Cardiothoracic or Circulatory procedures >19	Day case	£5,480
		Elective	£5,480
		Non Elective	£4,666
E99	Complex Elderly with a Cardiac Primary Diagnosis	Day case	£2,877
		Elective	£2,877
		Non Elective	£4,177
P25	Cardiac Conditions (includes Aortic Stenosis, multiple valve disease, Primary Pulmonary Hypertension etc)	Day case	£1,775
		Elective	£1,775
		Non Elective	£2,128
Q12	Therapeutic Endovascular Procedures	Day case	£1,492
		Elective	£1,492
		Non Elective	£2,128
Q19	Vascular access for renal replacement therapy	Day case	£1,575
		Elective	£1,575
		Non Elective	£5,465

Under that tariff regime, the tariff for providing PH services to NHS patients was based on a number of codes beside code P25 a catch all code as seen in Table 7.12. The tariff ranges from a minimum of £504 to a maximum of £5480 and the tariff for primary PH under P25 ranges from a maximum of £2128 to a minimum of £1775. These tariffs as they pertain to treating cardiac conditions in secondary or tertiary settings were not reflective of the cost of resources used for the assessment and follow-up components of PH services (Table 7.11).

The understanding of the nature of the condition is still emerging and a relatively rare condition, it raises challenges for clinical coding of this service. The tariff used for estimating the provision of PH services at Papworth stretched across a number of HRGs with a wide range of prices. The detailed calculation of the contract is not explored further in this thesis, for to do so would not provide additional clarity on the disaggregation of costs between clinical services and knowledge based outputs. The reimbursements based on tariffs for a range of applicable codes including P25 were estimated at £1.67m (Table 7.11) for year 2005-06. Such an estimate was judged as a reasonable basis for measuring the value of output of routine clinical services provided in a non-specialist setting as tariffs were based on average prices.

The HRG tariffs are based on case mix classifications of conditions, which mean no two patients in a classification, use identical resources but nevertheless do use a similar level. The use of such a classification for generating average prices does not invalidate these prices, in instances where there is some heterogeneity in resource use. As discussed in chapter 5, 5.4, section 7.2, however, such tariffs do not reflect the additional components of PH specialist services delivered by Papworth hospital as a specialist centre.

7.5. Phase I Findings: Costs, revenue, and "knowledge capital" generated

The costs of providing PH services at Papworth hospital in the year 2005-06 were estimated at £2.4m (Table 7.11) and the reimbursement for clinical services from the NHS was estimated at £1.67m (table 7.11). Such revenue, therefore, reimbursed only part of the £2.4m total cost of the services at Papworth hospital, thereby creating a difference or additional cost of £725k (Table 7.13). This raises the question of the nature of and reasons for these additional costs.

Table 7.13: Cost and revenue comparison: PH services at Papworth (2005-2006)

Total PH services cost excluding drug costs	£2,401,298	**Total cost excluding drug cost**
PH services Income Plan 05-06	£1,675,625	**Reimbursed on PBR tariff**
Additional Costs	**£725,673**	**Knowledge Capital costs?**

Some of this difference could be interpreted as the costs of treating patients with more complex needs relative to those included in the HRG tariffs, or inaccurate coding for tariffs leading to under claiming of service provision costs. On the other hand, the extra costs in a specialist hospital such as Papworth (Chapter 5, 5.4.2), can be attributed to providing processes for development of skills and understanding to manage better emerging PH services (Chapter 5, 5.4.1) alongside the routine specialist respiratory care as observed and discussed in sections 7.2, and 7.3.3.

There can thus be several reasons for the costs of service provision being higher than the HRG tariff reimbursement. Simplistically, the difference may be attributable to pure inefficiency or waste. Such an assumption is difficult to explore as the hospital was in financial balance for the year 2005-06. Detailed analyses of the practices at

Papworth hospital, as discussed earlier in this section, further indicate that this is a highly unlikely reason since productivity ratios, as reported, were above NHS benchmarks. Review of practice and strategy of the organisation revealed that generation, sharing and capture of new knowledge are key objectives, as indicated by the members of the Board (section 7.6). Another reason may be due to the HRG tariffs not reflecting the same level of resources as those used for the provision of the PH specialist service. Whilst some of the difference may be attributed to difference in use of resources, the analyses in this study (section 7.2) suggests another explanation.

The most likely explanation was that the extra costs related to the investments in non-patient care processes of research, staff and patient education, skills and service development (Table 7.3) aspects of PH specialised services at Papworth. Service provision for a serious respiratory condition such as PH involves the development of processes, routines and a culture of developing skills, service and understanding for better management of such conditions (Chapter 5, 5.4, section 7.2, 7.6). Analysis of the detailed cost estimates of PH service provision, derived by "bottom up" costing, indicated that some of the difference was clearly attributable to investment in "knowledge capital" generating activities.

Such analyses indicate that a significant part of the resources was used for service developments (section 7.2) in the course of PH services provision at Papworth hospital. Some extra resources, such as right heart catheterisation, CT angio scans and so on (Table 7.5, 7.6) could account for some extra costs relative to HRG tariffs. Additionally, the cost of the multidisciplinary team (Table 7.2) included a specialist registrar, a research registrar, an audit evaluation person and specialist nurse coordinator, none of whom would be required for service provision in a secondary care hospital. In providing patient related services, these staff were routinely involved in the development of skills and understanding of the processes for improving service provision. The multidisciplinary team meeting (section 7.2), patient pathway generation (Figure 7.1), generating guidelines for service provision (appendix 6) and supporting patient groups (section 7.7), are all processes that consume resources. At the same time, they encourage staff to reflect on practice and processes that develop appropriate skills and understanding of how to develop and better manage service provision. The resources used at Papworth were thus assessed as more likely to be extra resources used for providing specialised services which include the development of learning, skills and services as key components of the provision as highlighted by the Board (section 7.6).

Analysis reveals that 28% (Table 7.3) of annual staff costs estimated at £201.6k, related to costs of resources directed towards maintaining and developing the "human capital" aspect of the "knowledge capital" of the team (Figure 7.4). Such investments have an impact on the "relational capital", "public goods in health" and "capacity in health capital", as defined in chapter 4, 4.5, all aspects of the "knowledge capital" of the team and the organisation.

Additional spin offs that emerge from investment in the multidisciplinary team include the establishment of a research culture within the team (section 7.6). Learning was captured systematically thus converting service provision processes into routines within the hospital (section 7.2). Clinical and non-clinical members of the team were sensitised to new developments in the field undertaking further knowledge generation in their own right (section 7.2). The multidisciplinary working led to new knowledge generation through the sharing of knowledge at the personal and organisational levels as highlighted in the literature (Chapter 2, 2.3.2). An example of such a development was the "quality of life" instrument generated by the research nurse from the process of collecting data for monitoring patient progress (section 7.2).

The composite nature of specialised service delivery, research and skills development is not recognised in the current HRGs. The methods used to develop resource profiles in this study may be suitable for developing resource profiles for other HRGs. Such profiles could reflect the skills development, knowledge creation and service development aspects of such service provision, in the emergent stages of treatments for relatively rare conditions. They may further be used to code and provide robust data for deriving activity and cost estimates of such services.

The dissemination of knowledge gained from service provision appeared to enhance the reputation of Papworth hospital's PH services team within the NHS and other health networks. The lead clinical consultant, for example, was a member of a European taskforce and contributed to developing European wide guidelines for the diagnosis and treatment of Pulmonary Arterial Hypertension (Galie et al., 2004, 2009). This is seen as an example of a contribution made by the Papworth hospital team to the development of global knowledge in PH treatments and service provision.

Papworth hospital aims to deliver health services for patient care and additional outputs, namely processes for skills, knowledge and services development as observed in section 7.2, 7.3, which was reflected to a significant extent in the additional costs. The extra costs of £709k (Table 7.14) can thus be reasonably interpreted as an estimate of the "knowledge capital", at a minimum, that is co-created in the provision of specialised PH services. Further analyses in section 7.6 and section 7.7 revealed that in the year 2005-06, PH research charitable funds provided £58.7k plus £11.5k (Table 7.14) towards knowledge creation and sharing activities. Other PH charitable funds provided an additional £8.6k (Table 7.16) towards such activities.

The ability of Papworth hospital to attract the additional funds for developmental activities can also be interpreted as indicative of society's collective willingness to pay higher values for the health services delivered in a developmental and learning environment. Since these funds were freely given, the additional price must be perceived as good value for these additional outputs. The perspective and objectives of the Papworth hospital Board of directors in relation to these funds and investments made from such funds was sought and further analysed next to provide the strategic perspective to counterbalance the PH team's operational perspective.

7.6. Phase II: Qualitative analysis of Papworth hospital strategic perspective

In Phase II data collected through semi-structured interviews with the Papworth hospital Board of directors help to understand how the joint production of health services and knowledge is strategically perceived. The formulation of organisational policies, which direct the management of resources in an organisation delivering specialised health services, was thus explored. Analysis of this data using the "dimensions of knowledge capital in health" model (Chapter 4, 4.5) provide insights to categorise the components of "knowledge capital" in health as discussed below.

The interview transcripts, labelled BM1 to BM8, are reviewed in phase II to understand the strategic perspective for specialised service delivery and knowledge creation, including research (Chapter 6, 6.3). The model "dimensions of knowledge capital in health" served as a framework (Chapter 4, 4.5) to analyse the perceptions of the executive directors on the impact of NHS policy changes in terms of the hindrances and aids to service delivery and knowledge creation.

Firstly, Papworth hospital's strategy aims for innovation in service provision (www.papworthhospital.nhs.uk). Consistent with this aim, all Board of directors saw research or knowledge creation as fundamental to the provision of specialised health services. The following quotes from the interview data provided evidence of this.

> "Papworth is about leading edge medicine with, where possible, high research potential" (interviewee BM2 line 28).
>
> "Expectation of being the national if not in the world leader set……..take something on and turn it into something that becomes mainstream"(BM4 line 82-85)
>
> "Papworth has been clinical, so that the service obviously is an important part and much of the knowledge creation we have done has been from service outwards .... repertoires of studies developing services such as transplantation over the years or new technologies."(BM8 line 7-10)
>
> "One of the responsibilities of specialised hospitals has always been to innovate and then develop the innovations to a point where they become routine" (BM1, line 116-117)
>
> "Is a high standard hospital that does research related around their clinical work" (BM 8 line110-111).

> “Our responsibility is to kind of head up the next developments and aspects of service that we provide which perhaps started as specialised (but) will in the scheme of things become routine” (BM6 line 8-9)
>
> “Papworth delivers service to patients……integral to that and paramount is that it is a research organisation….developing new techniques in order to make those (services) deliverable in district general hospitals (BM5 line5-7)
>
> “We would die if we were just a service providing organisation” (BM8 line 12).

The above views in the context of this study confirm that Papworth hospital is continuously aiming to push the boundaries of service provision in order to develop new treatments which then become routine (www.papworthhospital.nhs.uk). The development of treatments was seen as a core function of the organisation, in other words, as a research pipeline for service developments.

Secondly, the Board saw the need to achieve and demonstrate to the NHS that quality standards and outcomes were achieved locally for the small critical mass of patients that required cardiac and respiratory specialised health treatment. Achieving such standards was seen as essential to attract continued investment in treatments that are emerging such as for PH (interviewee BM1 line 42). Research is seen as integral and core for the existence of the organisation and investing in transferring knowledge out to non-specialist hospitals and GPs (Table 7.19). Additionally, the benefit of wider dissemination of knowledge gained by being at the forefront of development, of enhancing the professional reputation of Papworth hospital's clinical teams and hospital was recognised. This approach, whilst appearing to give away internally generated benefits, aids the generation of the intangible "relational capital", "public goods in health capital" and some "capacity in health" as defined in chapter 4, 4.5. These components of "knowledge capital" in health are not clearly distinguishable as distinct parts, but create a greater value for the organisation than that which is given away.

Thirdly, the hospital management see research or explicit knowledge creation as a fundamental responsibility of all disciplines, and not exclusively as the preserve of clinicians. This was highlighted in this study by the words of the Board members.

> “The process of research is fundamental and everybody is engaged in the process from our medical records department that pulls out the notes for research endeavours, to the patient service managers, nurses, technicians, clinicians” (interviewee BM3 line 97-101).
>
> “Within their field of expertise they will identify research and move that forward which then becomes routine” (BM6, line 22-23)
>
> “Papworth is ….committed to research and moving that (research) forward because basically it is having to invest its own money" (BM4, line 26-27)

These views indicated that research culture or generation of new knowledge was integrated into its operations through operational and human resource policies. The human resources policy in relation to contracts for staff have time allocated for research and learning as standard as evidenced by the following quotes.

> “Our consultants …a large proportion of them maintain one programmed activity session (PA) for research (BM5 line 275-276)
>
> “As an organisation we have an expectation, it is written into job plans as well to a degree that research is undertaken” (BM6 line 17-18)

> “People want to come and work at Papworth because they know that we are a big research organisation that makes the time to invest in them as researcher” (BM3, line112-113)
>
> “The human capital would be enhanced by being able to attract other people etc. many of which will be funded by research and then it will feed back into better health care.”(BM 8 line 141-143)
>
> “In the specialist setting whether it is nurses, technicians and our healthcare professionals, they have additional training over and above the basic qualification. We continue to develop that while they are here…(BM6, line 43-44)

This routine investment in "human capital" development created the research culture that promotes new knowledge creation from the operational perspective and the various professional disciplines, from clinical to support services (BM3 line 97-101, BM6 line 43-44). Such a policy acts to enhance the reputation of Papworth hospital as an employer for developing staff skills, though the organisation may not fully derive the benefits of such skills development. The longer term impact of these policies is generation and maintenance of both internal and external relationships resulting in "relational capital" for the organisation and "public goods in health" and "capacity in health" for the NHS and beyond (Figure 7.4). It is not clear how performance on these aspects of staff and capacity development achieved by the various clinical teams are judged and monitored. Additionally, the NHS performance framework (Figure 6.1) does not provide for such monitoring, hence judging comparative performance of hospitals in this regard is challenging.

Fourthly, the Board of directors perceived the clinical strength of Papworth hospital to be in translational research that is translating medical research into practice as evidenced by the following quotes.

> "Innovate and develop the innovations to a point where it becomes routine" (BM1 116-117).
>
> "Our initial perspective is from service outwards rather than (research) bench inwards" (BM8 line 10-11)

These views are consistent with the position of being one of the national centres for cardiac and respiratory diseases and surgical interventions for PH in the NHS (Chapter 5, 5.4.1). In order to maintain such a position, Papworth hospital's management systems and culture include knowledge creation and dissemination as an integral aspect of service provision to attract the appropriate kind of staff as indicated by the following quotes,

> "People have to have the desire when they come here, that they are not only delivering service but actually changing service" (BM5 line 24)
>
> "Trying to find ways to incentivise people to translate what they know into best practice that comes from research that comes from being around the place and understanding how things work" (BM3 line 121-123)

Understanding the sources of its strengths Papworth hospital policies allocate resources to enable reflection and review of practice which capture learning that is generated in service provision (Chapter 3, 3.3, section 7.2, Figure 7.3). Resources directed towards service provision, as discussed in chapter 2, 2.4, thus simultaneously enable knowledge creation and service development (section 7.2), thereby generating "human capital", "public goods in health", "capacity in health capital" and "relational capital", all components of "knowledge capital" in health.

Nevertheless, there was evidence to suggest that greater management focus tended to be on aspects that were part of external performance management targets, such as delivering on 18 week targets (BM 4, line 188-192). Such a view was reflected in the following words of the project consultant supporting the organisation's move to Cambridge, near the University of Cambridge:

> “The clinicians who are delivering a service don’t really have the time, so much pressure is being put to deliver the service and to achieve activity targets, and waiting times and so on. It does not leave an awful lot of scope for research (BM 7 line 33-36).

NHS targets, therefore, was perceived to be of a higher priority. Whether this would be true under rigorous scrutiny is debatable as the Board of directors intuitively recognised research and service developments as vital for its existence as a centre for specialised health service and for generating additional revenues. Such perception was linked to the larger share of revenues reported in NHS accounts stemming from the contracts for direct patient care services.

Furthermore, the changes in national resource allocation policies namely, Payment by Results (PBR) and an R&D levy, appeared to create certain ambiguities of direction and lack of continuity from policy makers, as reflected in the following words:

> “One minute the view of the health service…. is a market…then a system where competition is not the be all and end all” (BM 2, line 236-237).

> “I think because we are doing well financially, we can afford to be reasonably relaxed that it (specialist skill) is sort of shared. I think what we are constantly trying to do is to decipher the signs from the Department of Health as to whether they want a competitive market or want a top down system. At the moment it is very much a top down system where they don’t want necessarily units, hospitals competing with each other. On the other hand they then talk too in some places they do want competition because only through competition, in their opinion, will standards be driven up. It is quite difficult for hospitals to one minute know how they are expected to behave, for example you talk about our information being taken on to a greater good of the health service. That is exactly the sort of cultural background we have come up in.... But equally you could argue that we are giving away our intellectual property” (BM2 line153-162).

Such national policies and direction, therefore, appear to create ambiguities in terms of generating health care knowledge even though the jointly produced "public goods" outputs are overtly recognised.

In summary, the Board of Papworth hospital as a specialised health service centre in the NHS intuitively recognised the importance of the intangible and "public goods" aspects and its co-creation in health service provision. The Board continues, therefore, to direct resources towards generating and maintaining knowledge generation activities recognising the "relational capital" and "public goods in health capital" (Chapter 4, 4.5) that yield long run benefits generated for the organisation, namely "knowledge capital" in health. Such investments were made despite national policies (Chapter 6, 6.2) which appear to be aiming for short run efficiencies. Nevertheless, in a specialist hospital funded mainly by public funds, the significant dilemma posed for management is that health system policies do not explicitly and financially recognise shared benefits such as "public goods in health" and "capacity in health" generated by service provision.

7.6.1 Discussion of qualitative analysis

"Knowledge capital" in health (Figure 4.2), consists of "human capital", "tangible capital" and "relational capital" identified in previous studies undertaken to define and measure "knowledge capital" (Chapter 2, 2.5). However, in health service, in addition to "relational capital" there is the "public goods in health" aspect created by the "caring externality" and generic nature of some of the knowledge created, which health organisations need to manage. The importance of using knowledge that is generated in the process of service delivery further add to the dimension of "capacity in health", a benefit that spills over into the health system.

The model "dimension of knowledge capital in health" (Chapter 4, 4.5) provided a suitable framework to analyse such outputs at Papworth hospital. These outputs were intuitively recognised at Papworth hospital and reflected in organisational policies.

There is, however, no framework to bring the component parts of "knowledge capital" together for an integrated review of performance. Funds from donations and research projects (Table 7.14; Table 7.16), which are based on its reputation for generating new knowledge, skills and service developments was used to support and maintain such reputation and skills. Such funds can be reasonably interpreted, therefore, as the returns generated by Papworth hospital on its stock of "knowledge capital" thereby becoming a proxy quantitative measure for it, discussed further in the following section.

7.7. Phase II: Quantitative analysis of returns on "knowledge capital" generated by the PH team at Papworth Hospital

Papworth hospital's annual financial accounts (Papworth Foundation Hospital NHS Trust, 2006) revealed that it achieved financial balance in the year 2005-06, which included the some additional revenues generated by the hospital from non-patient care activities such as research and charitable fund-raising (Table 5.1). The mobilisation of such funds relies on the reputation of the organisation as a centre of excellence in managing PH services (section 7.6). These funds were thus interpreted as a measure of its "relational capital" and as returns on the stock of "knowledge capital" of Papworth hospital's PH team. The "dimensions of knowledge capital" (Chapter 4, 4.5) provided a structure for the analysis of the expenditures from these funds, to identify the purposes to which such resources were directed. This analysis indicated the extent to which such resources support the maintenance and development of the stock of "knowledge capital" of Papworth hospital's PH team. These returns provided a feasible basis for estimating the stock of "knowledge capital" of the PH team through adapting the logic used by accountants and economists in the pricing of capital assets for evaluating capital investments or the sale of an organisation as discussed in chapter 2, 2.5. A monetary estimate of the stock of "knowledge capital" of the team, based on the average returns it generated, was £1.53m (Table 7.21).

Papworth hospital received £925k from the NHS research levy funding in the year 2005-06 as part of the "Cambridge University Hospitals Research Consortium". Additionally funds of £2.4m were attracted through donations and by undertaking further commissioned research projects. This funding was included in £7.4m other income in the hospital's accounts, is in addition to the £78.5m generated for patient care services (Table 5.1). Analysis of the details of Papworth hospital's NHS charitable funds accounts highlighted that funding from charitable donations and income from research activity support the development of PH services at the hospital. Research charitable funds (Table 7.14) and other charitable funds (Table 7.16) generated by the PH team over an 8 year period were summarised. Analyses using the "dimensions of knowledge capital" (Figure 4.2) further highlighted the nature of investment provided by these funds. The details and analyses of funds generated from research projects (section 7.7.1) and other charitable sources (Table 7.7.2) follow.

7.7.1 Research charitable trust funds of PH services

The PH team through conducting externally commissioned research, mainly from commercial sources or sometimes charities, generated funds of £544k over the years 2000-2007 (Table 7.14). These are accounted for in separate Charitable Trust accounts. It is during years 2000 to 2007 being delivered in Papworth Hospital as diagnosis and care of PH patients was emerging. The research projects consist of clinical research projects, audit projects and clinical trials. Funds used from such charitable trust accounts to support PH team's research and service development activities are accounted in Papworth hospital's NHS accounts in the year as other income and PH service and research expenditure

Charitable trust funds generated from research activity, that is explicit knowledge creation, were in the form of fees for undertaking commercial and non-commercial commissioned research. Commercial clinical projects paid fees based on the number of patients recruited, which the PH team utilised for funding additional clinical and administrative staff time that arose from undertaking such projects. The expenditure reported in these research charitable funds is classified into pay and non-pay expenditure. Expenditure classified as "pay" consists of additional staff time within the PH team. Any expenditure incurred for the research project such as purchase of equipment, attendance at research seminars and dissemination of findings of research is categorised as "non-pay" in the accounts.

Table 7.14: PH Research charitable trust funds - Income & Expenditure

Pulmonary Hypertension- Research Income and Expenditure Financial years 2000 to 2007				
	R & D Income generated	**Staff Costs**	**Non staff costs**	**Carried to following years**
Financial Year	**£**	**£**	**£**	**£**
1999 - 2000	3,500			3,500
2000 - 2001	29,225		-7,122	22,103
2001 - 2002	45,116	-1,082	-10,077	33,957
2002 - 2003	13,152	-12,655	-9,968	-9,470
2003 - 2004	28,413	-30,846	-6,486	-8,919
2004 - 2005	102,119	-27,710	-7,193	67,217
2005 - 2006	132,909	-58,725	-11,538	62,645
2006 - 2007	189,627	-122,801	-40,947	25,879
Grand Total	**544,062**	**-253,819**	**-93,331**	**196,912**
Percentage of total income		**47%**	**17%**	**36%**
2007 - 2008	127,490	-112,798	-35,879	**175,724**

The details of the income and expenditure of research charitable funds for financial years 2000 to 2008 as accounted and reported to the Charities Commission are shown in table 7.14. A sum of £253,819 or 47% of these funds was used for additional staff time. A smaller amount of £93,331 or 17% supported other non-pay costs. At the end of year 2007, an amount of £196,912 or 36% of income was carried forward into subsequent years. At the end of the financial year 2007-2008, these research charitable funds revealed a cash reserve of £175.7k (Table 7.14). These provide for expenditure in future years where projects can straddle a number of financial years. The income generated and expenditure may be incurred in different financial years. Any surplus funds from such projects were available for supporting future PH service developments. The amount of funds generated over the years appeared mainly to indicate the strength of the reputation of the PH team for research.

Using "dimensions of knowledge capital in health" (Chapter 4, 4.5) an analysis of funds generated and investments made from the PH research charitable funds towards "knowledge capital" of the PH team is shown in Table 7.15.

Table 7.15 : Income and Expenditure of Charitable Funds from Research Projects

Papworth Hospital PH team funds from Research Projects - Years 2000 to 2007			
Income and Expenditure	**years 2000-2007**	**Average Per Year**	**% of returns**
Income:Returns - generated (table 7.14)	£544,062	£68,008	
Expenditure: (table 7.14) **"Human Capital" investments**	£253,819	£31,727	**47%**
"Public health goods capital" investments	£93,331	£13,333	**17%**

Research funds generated by the PH team over the period translate to an average return of £68k (Table 7.15) per year. These funds supported investments in processes, skills and knowledge to develop and improve the PH services for management of the condition. Such investments took the shape of funding for additional clinical and administrative staff time at the hospital. Of such investments 47% (Table 7.15), was categorised as development of the "human capital" because staff skills and knowledge are developed as a direct result of involvement in research projects as highlighted in section 7.2, 7.6 and an earlier study (Leitner and Warden, 2004). A further 17% (Table 7.15) of these funds were utilised for activities such as staff attendances at related conferences, development of patient support group, research dissemination activities, the maintenance and support of the wider dissemination of skills and knowledge gained from internal research. Such expenditures thus contributed to the maintenance and development of reputation, thereby the "relational capital", "public goods in health" and "human capital" dimensions of "knowledge capital" of the team and the hospital. The team carried forward on average 36% of such funds for use in subsequent periods, (Table 7.14) a prudent financial management strategy.

Furthermore, when clinical trials were undertaken at the hospital the R&D infrastructure cost related to the project and a 30 percent overheads charge claimed from the project funding body. These charges reflected some of the additional costs to the organisation in undertaking clinical trials. Such expenditure contributed to additional investment in the "human capital" and infrastructure of the hospital as staff skills and systems were updated for undertaking such projects. Additionally, the NHS as a health system benefited as trained staff move from one organisation to another within the NHS, as recognised by the Board of directors at Papworth hospital (section 7.7). The increased skills and capacity was seen to spill over into the wider NHS and are therefore interpreted as "capacity in health" a dimension of "knowledge capital" in health. When trained staff move to organisations outside the country then the benefits spill over into the global health system.

For instance, Papworth hospital supports the additional cost of one of the two specialist registrars required in the multidisciplinary team (Table 7.2) from such funds while the other is supported by clinical services funding. However, as service and research are co-created it can be argued that these funds from non-NHS sources (Table 7.15) jointly met the costs of staff time for patient care and research including the indivisible activities. On completion of training specialist registrars at specialist hospitals are able to move to other organisations in the NHS or to other health institutions around the world to further their career. This can be argued is a reflection of the reputation of Papworth hospital and the training it provides.

Such investments which direct resources at developing skills, processes and knowledge in the course of providing externally commissioned research have steadily increased (Table 7.14; Chapter 3, 3.5). This in turn increases the PH team's stock of "knowledge capital" as evidenced by increasing returns (Table 7.14). It can thus be interpreted that Papworth hospital has simultaneously generated "relational capital" and "capacity in health", as defined in chapter 4, 4.5, to develop and maintain its stock of "knowledge capital".

7.7.2 Other charitable trust funds: donations and grants

Papworth hospital attracts other charitable funds in the form of donations and grants from patients, charities, other organisations and fund raising activities. Such funds are managed as other charitable funds distinct from research projects related charitable funds. It can be argued that the donations and grants from individuals and organisations received by the PH team is partly in recognition of the quality of services provided and the reputation of the team and organisation to develop skills and processes to improve the provision of specialised health services. In other words, such funds can be interpreted as the returns generated on the organisation's reputation for the creation of "public goods in health" in the form of transferable skills and understanding to better manage health services.

Over the years 2000 to 2007, the PH team attracted funds totalling £98.8k (Table 7.16) from charitable sources. From these funds £79.3k is utilised to support expenditure related to the wider aspects of PH service provision as detailed in Table 7.16.

Table 7.16 PH other charitable funds Income & Expenditure (2000 -2006)

PH team Other Charitable Fund Income and Expenditure - Financial years 2000 to 2007									
	Years								
	1999 -00	2000 - 01	2001- 02	2002 - 03	2003 - 04	2004 -05	2005 - 06	Grand total for 8 Yrs	
Income	£	£	£	£	£	£	£	£	
Donations	5,249	10,731	7,342	20,137	13,193	23,108	14,207	**93,968**	
interest	41	254	309	543	798	165	588	**2,698**	
other							2,152	**2,152**	
Income Total	**5,291**	**10,986**	**7,650**	**20,680**	**13,991**	**23,273**	**16,947**	**98,818**	Line 1
Expenditure									
administration	- 20	- 103	- 262	- 216	- 330	- 422	- 316	**- 1,668**	Line 2
Patient equipment				- 2,772	- 6,449	- 13,714		**- 22,935**	Line 3
Patient education		- 1,936	- 1,814	- 2,601	- 3,467	- 3,331	- 4,586	**- 17,735**	Line 4
Research				- 1,000	- 118	- 34	- 1,327	**- 2,478**	Line 5
Staff equipment		- 1,739		- 184	- 3,850	- 489	- 843	**- 7,105**	Line 6
Staff Training	- 499	- 1,751	- 1,797	- 4,001	- 6,722	- 11,091	- 1,553	**- 27,414**	Line 7
Expenditure Total	**- 518**	**- 5,529**	**- 3,873**	**- 10,774**	**- 20,935**	**- 29,080**	**- 8,625**	**- 79,334**	Line 8
Income less Expenditure		**5,457**	**3,777**	**9,906**	**- 6,943**	**- 5,807**	**8,322**		
Funds carried forward	**4,772**	**10,229**	**14,007**	**23,913**	**16,969**	**11,162**	**19,484**		

Analyses of these funds' expenditure of £79.3k as in Table 7.16 indicate that activities, such as patient education and development of patient support groups to capture learning from patient experiences and expert patients (Line 4), are supported. Activities that support the building of clinical staff relations within the emerging PH community of researchers through the dissemination of learning, conference attendances and GP study meetings (Line 7) are funded. Equipment for research work and new equipment for patient use such as pumps for delivering drugs intravenously (Lines 6, 3), research related expenses and additional temporary administrative support for the PH team (Lines 5, 2), not funded by the NHS are supported.

All these activities aim to increase the knowledge and competencies in the treatment of the condition of PH, develop skills and add to the "human capital" and "public goods in health" components of "knowledge capital" of the team. As with research charitable funds monies were carried forward for future use.

The benefits from the outputs described above, such as patient newsletters, GP study meetings and dissemination of research findings at conferences (Table 7.19), extend wider than the hospital and patient. In this way these processes make such information and insights into "explicit knowledge" (Chapter 2, 2.3.2, Figure 7.3) accessible to the wider health systems. The developments in IT mean electronic versions of such outputs are potentially accessible to a global audience.

It can be argued further that these investments in staff and patient education increase the "capacity in health" of the health system as the patients, staff and GPs increase their knowledge base. As the number of patients and families involved in the management of the condition increases, expertise in patients is developed. Furthermore, as patients become increasingly proactive in managing their condition staff can support more patients (section 7.2). This increased expertise is categorised as "public goods in health" and "capacity for health", as defined in chapter 4, 4.5. With the increased accessibility provided by information technology for the sharing of such experiences and knowledge one could argue a "global capacity for health" in the provision of PH services is created.

Using the "dimensions of knowledge capital in health" (Chapter 4, 4.5) the components of "knowledge capital" developed through the expenditure of £79.3k (Table 7.16) from these charitable funds are categorised in Table 7.17. As with the funds generated from research activities, it can be argued that the total sum of £98k (table 7.17) generated from donations and grants over the period, is the monetary value of the returns generated from the "relational capital" aspects of "knowledge capital" of the team. The ability to attract these funds suggests that the reputation of the team for providing quality PH services is strong and growing.

Table 7.17: PH other charitable funds expenditure (years 2000-2007)

Papworth Hospital PH Other Charitable funds - Years 2000 to 2007			
	yrs 2000-2007	**Av. Per Year**	**% of returns**
Returns on "knowledge capital"- generated (table 7.16,line 1)	£98,818	£14,117	
Tangible capital -investment (table 7.16, lines 2+3+4)	£31,707	£4,530	**32%**
"Capacity in health capital" investment (table 7.16, lines 5+6)	£29,892	£4,270	**30%**
"Public health goods capital" investment (table 7.16, line 7)	£17,735	£2,534	**18%**
Funds carried forward	**£19,484**	**£7,054**	**20%**

Investment in "tangible capital" (Chapter 4, 4.5) PH services namely equipment for patients and staff at 32% was the greater share of funds generated. Of the funds generated 30% (Table 7.17) was investment in "capacity in health" through funding staff attendance at research meetings and conferences and on resources for research projects. The resources directed towards patient education and support group development of PH patients was the smaller share at 18% (Table 7.17). The benefit derived from such expenditure is interpreted as maintaining and developing "public goods in health" (Chapter 4, 4.5), as these benefits are accessible to the wider NHS. As with research charitable funds, 20% (Table 7.17) of the funds were carried forward at the end of the financial year 2006, which provided a flexibility of use that NHS funds cannot. As a matter of policy, therefore, not all the charitable funds generated are utilised immediately to ensure unanticipated priority developments can be funded. Here the priority will be determined by the PH team, and not necessarily in line with hospital or NHS priorities.

As observed at Papworth hospital, such investments raise the health knowledge in the community and the capacity within the health system to generate new knowledge improving service provision (section 7.2, 7.6) and leading to an increase in the reputation of the team (Table 7.14, 7.16). The capacity developed for service provision does not distinctly fit into either clinical services or research but is a combination of both (section 7.6).

7.7.3 Summary of investments in "knowledge capital" of Papworth hospital PH team

The PH team generated charitable funds totalling £643k (Table 7.20), £544k (Table 7.14) from research projects and grants and £98k (Table 7.16) from donations and interest. Analyses of investments from both these types of charitable funds, as discussed earlier, are summarised in Table 7.18.

Table 7.18: Summary of Investments in "knowledge capital" of PH team

Investments in Papworth Hospital PH health services	Yrs 2000 - 2007	Average per Year	% of total
	£	£	
Human capital (table 7.15)	253,819	36,260	**60%**
Tangible Capital (table 7.17)	31,707	4,530	**7%**
Public Health Goods Capital (table 7.15+ 7.17)	111,066	15,867	**26%**
Capacity in Health (table 7.17)	29,892	4,270	**7%**
Total	**426,485**	**60,926**	
Total Returns (Research & Donations)	**£642,880**	**151%**	**% returns**

A sum of £426.5k from the two types of charitable funds was invested during years 2000 to 2007 to develop the "knowledge capital" of the team. The largest share of 60% of the total investments is in "human capital" followed by 26% in "public goods in health". It may be argued that this level of investment generated returns of £642.8 (Table 7.18) which is 151% of investment. This level of investment in these activities appears to vindicate the hospital management's perspective that development of these intangible resources as integral to the provision of specialised health services (Chapter 6, 6.2.4, Chapter 7, 7.2, 7.6). The returns generated from the dissemination of new knowledge through research conferences and patient education is not easy to measure in monetary or non-monetary terms. Such investments nevertheless indicate that the hospital management intuitively recognise (section 7.6) the link between these investments and the reputation and development of capacity of the organisation and health system.

Investments from these funds are demand driven and not explicitly aligned to an organisational plan for the development of PH services therefore raising a danger of creating fiefdoms within the organisation. The calls on these funds are in effect an early indicator of costs the NHS may need to pick up as treatments develop in these conditions. Recognising such investments and cross referencing to the assets created within the NHS could add to forward planning within the health system.

7.7.4 Non-monetary metrics for measuring "knowledge capital" in health

The outputs, in terms of increased capacity for knowledge creation and increased dissemination of health knowledge, that occur in tandem with health service provision are difficult to measure in purely monetary terms. Nevertheless, it is necessary to monitor and manage processes that create such additional outputs in non-monetary terms in order to maximise the investments in health. At Papworth hospital these kinds of outputs were monitored in non-monetary terms (Table 7.19) in order to manage the organisation's performance in delivering outputs of research activities. Some of these non-monetary measures used at Papworth hospital may also be suitable as a non-monetary measure of returns from investment in processes that develop skills and knowledge in health service provision.

Table 7.19: Possible non-monetary metrics for "knowledge capital"

Outputs	Units	Relevant Dimensions of Knowledge capital
Number of Clinical Trials	16	National capacity in health
Peer Reviewed Publications	20	Human Capital/ Public Goods in health
Research Meetings (monthly)	12	Relational Capital/Public Goods in
Education Meetings for GPs (monthly)	12	Public Goods in Health/ National capacity in Health
National cardiovascular & respiratory medicine meeting	2	Human capital/Relational Capital/Public Goods in Health
International Cardiovascular & Respiratory meeting participation	7	Human capital/Relational Capital/Public Goods in Health
PH patient newsletter contribution (monthly)	12	Relational Capital/Public Goods in Health/ National capacity in Health
Patient support meetings contribution (quarterly)	4	Relational Capital/Public Goods in Health/ National capacity in Health

The number of clinical trials undertaken indicates the relative capacity of the organisation to undertake and utilise processes and knowledge created in the course of service delivery. The number of clinical trials therefore undertaken within the NHS and those of public interest even when not attracting additional monies, should be included as such clinical trials can expand the knowledge base of health in areas of public interest. Likewise, peer reviewed journal publication is used as a mechanism to monitor and manage knowledge creation and the capture and dissemination of knowledge on emerging treatments.

Papworth Hospital as a specialist hospital sees development of specialist staff and disseminating new knowledge created in PH as integral to the organisation's existence. The production of a PH patient newsletter and facilitation of a patient support group were supported as these activities were seen as an important part of service provision (section 7.2). Table 7.19 lists some of the non-monetary measures used for measurement of such outputs that could well serve to measure "knowledge capital" in health. These measures provide an indication of the level of activity in non-patient care, whilst the quality aspects will need to be informed by other factors inclusive of citation numbers of papers and impact factor of journals as used in measuring research activities. Impact factor is used as a proxy measure for the relative importance of a journal within its field, the higher numbers are judged to be of better quality. Further research based on such measures needs to include the implementation or wider use of knowledge generated in practice and potentially cross-referenced with proxy monetary measures.

7.8. An estimate of the “knowledge capital” of Papworth hospital PH team

The PH team attracts funds for research and as donations based on the reputation of Papworth hospital as a centre of excellence for PH services (Chapter 5, 5.4.2) and through the reputation of the PH team for developing the processes, skills and knowledge in this field. These funds as discussed (Chapter 3, 3.3.2; section 7.6) are interpreted as the returns generated on the "knowledge capital" base of the organisation, in monetary terms. All financial assets in the NHS were expected to generate at least a 6% return on capital employed prior to the financial year 2003, which changed to 3.5% from 2004 (DH, 2007b).

Over the years 2000-2007, the PH team generated charitable trust funds totalling £642,881 (Table 7.20) through commissioned research projects, donations and grants. The underlying principle for estimation of the price of capital assets, including intangible assets, as earlier discussed (Chapter 2, 2.5.1,2.5.2), is that it can be derived based on estimated flows of funds for a risk adjusted rate of return in other words the opportunity cost of capital (Andriessen, 2004; Drury, 2006). The value of capital assets required therefore to generate a given return can be estimated by dividing funds generated by the required rate.

Table7.20: Research & Charitable Income of Papworth hospital PH team

PH team Research and Other Charitable Fund Income - Financial years 1999 to 2007									
Income	**Years**								
	1999-2000	**2000- 01**	**2001- 02**	**2002 - 03**	**2003 - 04**	**2004 -05**	**2005 - 06**	**2006 - 07**	**Grand total**
	£	**£**	**£**	**£**	**£**	**£**	**£**	**£**	**£**
Research Income (table 7.14)	3,500	29,225	45,116	13,152	28,413	102,119	132,909	189,627	**544,062**
Donations & other funds (table 7.16)		5,291	10,986	7,650	20,680	13,991	23,273	16,947	**98,819**
Total Funds Generated	**3,500**	**34,516**	**56,102**	**20,803**	**49,093**	**116,111**	**156,182**	**206,574**	**642,881**
								Annual Average income	**£ 80,360**
NHS Expected rate of return	**6%**	**6%**	**6%**	**6%**	**6%**	**3.5%**	**3.5%**	**3.5%**	**4%**
Income averaged	**5 year average = £32,803**					**3 year average = £ 159,622**			
Estimate of "Knowledge capital" @ expected Rate of Return	**5 year average @ 6% rate of return = £ 546,713**					**3 year average @ 3.5 % rate of return = £ 4,560,636**			
Estimate of "knowledge capital" based on 6% for 5 years and 3.5% rate of return for 3 years									**£ 2,553,675**
Estimate of "knowledge capital" based on 8 year average 4% rate of return									**£ 2,009,002**

To estimate a value of "knowledge capital" required to yield a return of £80.4k per annum can be derived using a method similar to that adopted in pricing capital assets of an organisation (Chapter 2, 2.5.1). Table 7.20 details the estimates of "knowledge capital" derived based on the annual funds generated and the rate of return required in that year. Using an average rate of 4% incorporating the lower rate required for years 2004-07 produces a higher estimate. The lower the rate of return required the higher the value of capital base. Estimates using lower rates, however, will not be credible as returns generated are not definite and in a linear growth pattern nor are the cause and effect relationship of investment immediate and direct.

The annual average income of £80,360 (Table 7.20) does not convey the rate of growth of funds generated, however, it is a more credible basis for estimation of values. This is because it evens out the non-linear flows and somewhat reflects a longer timescale over which such benefits are generated.

Table7.21: Estimate of "knowledge capital" of Papworth hospital PH team

Returns on "knowledge capital" in health services	**Yrs 2000-2007**	**Average per Year**	**Estimate of "knowledge capital"**
	£	**£**	**£**
Donations - (table 7.17)	98,818	12,352	
Research income (table 7.15)	544,062	68,008	**based on 6% returns**
Total	**642,880**	**80,360**	**1,339,334**

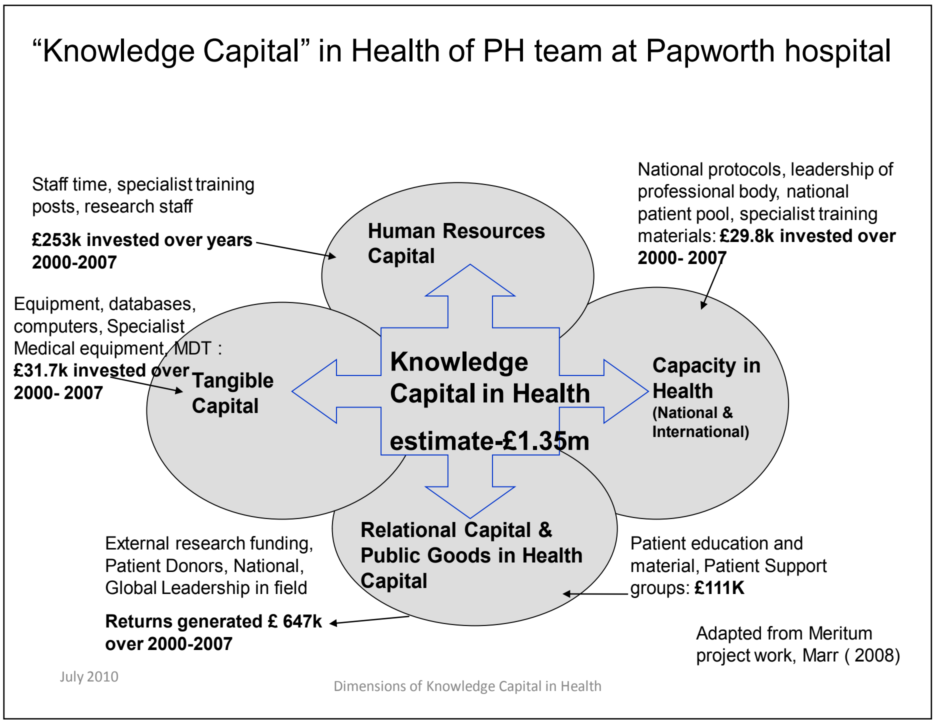
In this study using the prudence principle, an estimate of £1.339m (£80,360/0.06) (Table 7.21) is derived as a minimum value of the stock of "knowledge capital" of the Papworth hospital PH team, using 6% rate of return. This estimate is subject to any hidden liabilities, an area outside the scope of this study.

Using such a monetary estimate, although contestable, helps shed light on the exposure of health organisations to potential long term financial requirements, if such non-NHS funds were not available for supporting these investments in hospitals (BM1 line 275-277). These estimates need to be counterbalanced with estimates of potential "liabilities" that are not readily visible, for example liabilities arising from potential risk in processes and systems to safe service delivery. Such a systematic review is necessary as reputation based funds are vulnerable in the event of an error in processes or judgement occurring in the course of service provision.

7.8.1 Measures of the “knowledge capital" at Papworth Hospital

The stock of "knowledge capital" of the PH team in Papworth hospital, together with the nature and investments contributing to the various dimensions is illustrated in figure 7.4.

Figure: 7.4 "Knowledge capital" of PH team at Papworth hospital



Investments in the dimensions of "knowledge capital" are supported by the PH charitable trust funds as discussed in section 7.7 (Table 7.14; Table 7.16) and brought together in figure 7.4.

Papworth hospital as a specialist centre accumulates "knowledge capital" by the joint provision of specialised services and the processes and skills for improving service provision (section 7.5). Generation of research and charitable funds, as discussed earlier, is interpreted as reflective of the reputation and goodwill towards the hospital (BM 1 line 273-276, Chapter 3, 3.5) that provides an indicative monetary metric for identification and estimation of the “relational capital” and “public goods in health” (Chapter 4, 4.5) dimensions of knowledge capital.

Papworth hospital with a reputation as a leading specialist heart and lung hospital generated £7.4m income from charitable donations, research activity and other non-patient care services for the financial year ending 31 March 2006 (Chapter 5, 5.4.2). It can be interpreted as a reflection of the value placed on the reputation of the organisation. By the provision of research grants and donations funders are effectively buying some of the "public goods in health" outputs of Papworth hospital. The commercial and non-commercial funds that support the skills, knowledge and service developments in service provision, can be interpreted as society's willingness to buy such outputs from the hospital. Such funding is nevertheless provided to the hospital with the understanding that routine patient care is supported by NHS patient services funding.

Using the 6% rate of return required on financial assets employed in the NHS, based on this £7.4m (Chapter 5, 5.4.2) non-patient care income, a broad estimate of £123.3m can be derived for the stock of "knowledge capital" of Papworth hospital. This estimate reveals the scale to be 2.5 times that of the £50.2m tangible capital employed and reported in the hospital's annual accounts (Papworth Foundation

Hospital NHS Trust, 2006). This estimate, although contestable in part, by its scale makes "knowledge capital" a significant hidden resource of service provision to both health organisations and systems. Further research using this method is required to map the dimensions of "knowledge capital" of the hospital as a whole. These measures provide a feasible method, as a start, by which to estimate the monetary value of some of the returns from Papworth hospital's stock of "knowledge capital".

7.9. Research questions answered, lessons and challenges

This study makes a start at providing some understanding on the importance and the dimensions of "knowledge capital" in health service and estimations of the scale of its value as a resource in service provision. The "knowledge creation cycle" developed in chapter 4, 4.5 helped highlight that tacit and explicit knowledge is created and shared during the co-creation of specialised services and “knowledge capital” in health. Practitioners and managers of health services develop processes, systems and skills, as and when a practical problem arises during the course of service delivery (section 7.2). Routine organisational data such as those that form part of management accountancy reports provided, to a certain extent, a start for identification and measurement of categories of “knowledge capital” identified by previous studies (Chapter 2, 2.5) in monetary and non-monetary terms. Further additional dimensions such as "public goods in health" and "capacity for health" using the model "dimensions of knowledge capital in health" (Chapter 4, 4.5) were categorised for the PH team at Papworth hospital (Figure 7.1; Figure 7.4) in this study.

As discussed in chapter 2, 2.5, the non-excludability nature of these dimensions of "knowledge capital" means the organisation faces challenges in its measurement as an output of service delivery when using traditional financial accountancy guidelines. A joint economic accountancy method measuring "knowledge capital" based on opportunity cost of capital, as discussed in chapter 2, 2.5, using an input pricing approach, though imperfect for disaggregating joint inputs, is made feasible through a "bottom up" approach. In this approach the service providers' tacit insights made feasible the identification, allocation and costing of the tangible and intangible inputs of service provision. Additionally, this approach that is in common use provides a practical way to engage clinical teams in the identification of resources used and the estimation of costs of specific services making such estimates more reflective of practice. Furthermore, organisations within the NHS are being expected, within a timetable, to cost services provided using clinical staff inputs and resonates with the policy of accounting for cost of capital (DH, 2005a, 2008a). Estimates of the stock of Papworth hospital's "knowledge capital" derived in this study indicate it could be 2.5 times the value of its tangible assets (section 7.8)

The long term system wide benefits generated from such processes or systems development in an organisation, whilst currently not visible within the NHS performance management framework (Chapter 6, 6.2.7), become visible as components of "knowledge capital". Despite this absence, the service delivery team are acutely aware of such benefits forming the basis for funds generated through research and donations (section 7.2, 7.7). Since these funds support the development activities of the clinical team they are perceived as team reserve funds, particularly as the lead clinician is the trustee of such funds. Such arrangements pose the danger of creating fiefdoms within the organisation.

A framework for recognising the interdependency and measurement of knowledge based outputs becomes necessary in the management of health service as the present performance management frameworks in the NHS (Chapter 6, 6.2.7) do not. Additionally, although generation of charitable funds is in part related to the team's reputation for service delivery, research, skills and service development, these funds are currently accounted for separately through the Charities Commission and expenditure only at time of use within the NHS. "Knowledge capital" can therefore provide a framework enabling health service organisations to systematically recognise and manage the wider knowledge outputs that are co-created by such interdependency in service provision (Chapter 4, 4.5).

"Knowledge capital" in health service management, as highlighted by this study, can shed light on the performance of the organisation within the context of tradeoffs made between health service provision and the development of processes, skills and understanding that spill into wider health systems. Furthermore, a start is made for recognising, measuring and managing knowledge based outputs that are essential for safe service provision.

7.9.1 Learning for future studies

Data generated by a number of disciplines for different purposes, such as research, audit, service development projects and budgeting whilst used for the operational management of service delivery was not always brought together for wider sharing within the organisation. This data can be used, to an extent, in the identification and disaggregation of resources used for the joint production of services and "knowledge capital". Management accountancy processes within the hospital provided a useful framework for engaging clinical staff in the identification and disaggregation of resources and costs (Table 7.12; Table 7.18). This identification and disaggregation process was only made feasible by such engagement as the NHS recommends for generating reference costs (DH, 2005a, 2007c, 2008a).

The NHS performance management framework (Chapter 6, 6.2.7) reviews clinical service delivery and research performance separately, which means the tradeoffs made between short term efficiency targets in service provision and investment in knowledge creation are not readily visible. Furthermore, investment in intangible resources of the NHS organisation often come from non-clinical service provision (Table 7.18) which need to be reviewed in tandem with clinical care funding. As argued in this thesis, charitable funds generated by service teams from research projects, donations and grants can serve as a proxy monetary indicator of the reputation of the service delivery team to deliver quality services, skills and service developments. The income and expenditure of these charitable funds, when viewed as an integral part of management reports, provide a more rounded view of the organisation's long term and short term performance of service provision and "knowledge capital" generation.

7.9.2 Factors that helped and hindered this study

The serendipitous opportunity to support the hospital in its Foundation Trust Status application (Chapter 6, 6.2.7) meant acceptance of the researcher's presence in discussions of a confidential nature. Additionally, the hospital was embarking on developing a hospital wide service department level costing in anticipation of the requirement to report service level costs (DH, 2005a). This meant staff at Papworth hospital were sensitised to collecting data on resource use and saw this study as a learning vehicle.

In addition, changes such as Payment by Results and the commissioning of specialised services, which required costing at service level (Chapter 6, 6.2.7), were being envisaged in the NHS at the time of this study. In the meanwhile, the National Specialised Services Commissioning group was reviewing the requirement for Pulmonary Thromboendarterectomy (PTE), an intervention for PH patients, which required an expansion in PH services capacity to support diagnosis and post operative monitoring. These changes affect Papworth hospital as it provides specialised services for heart transplant, lung transplant, cystic fibrosis, and the emerging services of PTE, PH, implantation and removal of ventricular assisted devices (VADs). Prior to this study these specialised services were being considered for a costing exercise by the hospital. The request to study PH service provision was thus well received and participants were open to the research project.

The choice of a specialised service (Chapter 6, 6.2.4) meant the dimensions of "knowledge capital" had a higher resolution and were more visible as knowledge creation activity and overlapped health service delivery significantly. As a specialised centre, greater sensitivity to research issues was noticeable at the hospital. Patient related service provision and health research however are parts of an organic interdependent whole.

The use of mixed methods in the design of both phases of the study helped to ascertain the insights of the staff providing clinical service and the strategic direction for the organisation. The use of management accountancy processes of the hospital as a framework for collecting both quantitative and qualitative data enabled this study to engage the clinical staff for addressing the challenges of disaggregating joint resource use. A planned presentation to the board to share the findings of phase II of this study was not possible, however, due to tight time schedules of the Board meetings. Such a presentation could have stimulated a debate among Board members from different disciplines, leading to a more synthesised organisational view of the phenomenon of "knowledge capital" in health.

Encompassing both the operational and strategic perspectives in the design of this study enabled the capture of the wide spectrum of the impact of "knowledge capital" generation in a health system. To extend this study into the generalist hospital setting will therefore require more focused interviewing with service providers to enable disaggregation and allocation of the resources used between service delivery and knowledge generation.

7.10. Discussion

This study, by using the model "knowledge creation in health" (Chapter 4, 4.3), found that a specialised health service hospital sees service delivery, research and education as the core interdependent drivers of the organisation (section 7.7). The co-production of knowledge based resources with service provision was intuitively recognised (section 7.2, 7.7) by the hospital team. This recognition exists despite not being explicitly recognised or measured in the NHS performance framework (Chapter 6, 6.2.7). This lack of recognition could be due to the challenges of measurement (Chapter 3, 3.5) raised by the inseparability of service provision, education and "knowledge capital" generation. The strategic plan of Papworth hospital has separate targets and goals for delivery of clinical services, education and research, some of which are inherited from the Department of Health as discussed in chapter 6, 6.2.7, without explicit recognition of the interdependencies of these outputs.

This study finds that, despite the lack of recognition of such interdependencies, in practice the operations and human resources policies of Papworth hospital endeavour to achieve operational goals through a consistent approach to keeping skills and expertise development current in all the professional and administrative disciplines (Chapter 7, 7.2, 7.7). Such organisational policies act to add to the "capacity in health", as categorised in the "dimensions of knowledge capital"(Chapter 4, 4.5), of the health organisation and system. In this situation, "human capital" is jointly developed for the individual, organisation and system, with the organisation bearing the immediate monetary cost (section 7.7.3).

Therein lies the tension for NHS organisations in relation to increasing the capability for health service delivery in the national and global health systems with limited recognition in funding and performance management systems. However, this study finds that as a specialist centre there is intuitive recognition (section 7.7) that investments in the "public goods" dimensions of this resource enhances the stock of "knowledge capital" of Papworth hospital (section 7.8).

The availability of cardio-thoracic surgical skills, knowledge and expertise at Papworth hospital provided the cross-fertilisation of learning between specialities resulting in the development of PTE and PH services (section 7.2, 7.6). The NHS specialised clinical service contracts did not meet the full costs of PH specialist services provided (section 7.2). The contract whilst including some short term funds for research did not recognise the co-development of additional skills, knowledge and services in the course of providing treatment. The hospital, nevertheless, managed to balance its finances for that year by generating additional income from research and charitable funds (section 7.7.2). These joint outputs of increased knowledge and skills pools are currently not explicitly recognised within the performance framework or reimbursed within the NHS HRG tariff system. The Department of Health, at the time of this study, was considering the need for training more cardio-thoracic surgeons in PTE. This is in recognition of the additional national demand envisaged from increased diagnosis of PH, but no recognition of the tensions created in the hospital in terms of use specialist surgeon time and performance targets.

As a specialised services centre Papworth hospital continuously was making trade offs in allocating the scarce resource of cardio-thoracic surgery skills either to meet the targets of waiting time or the development of the capacity in the health system for an emerging treatment (section 7.2.3; section 7.6.1). Simultaneously, the funding of health service through HRG tariffs derived from averages raises issues around the robustness and appropriateness of the tariff for specialist services. The lack of an integrated mechanism for funding provision of health service post research means, in the case of emerging treatments, on completion of a research project, funding streams for resourcing the emerging service or ongoing research appear fractured. The long-term resource needs for the provision of such treatments, particularly development of capacity, do not appear to be considered in a systematically integrated manner within the health system. As the NHS shifts towards funding based on nationally uniform prices using HRGs, the impact on "capacity in health" and "public goods in health" aspects of the existing stock of “knowledge capital” needs consideration. There is a further risk that a systematic undervaluation of health services would result should any potential market based solutions, which do not by their nature value "public goods", be adopted in the future.

Furthermore, the emerging nature of specialised health services resulted in the hospital routinely investing resources for setting up systems to enable systematic collection of data for service provision, research, education, skills development and clinical trials (section 7.2.1; 7.7.1). Analysis of these input costs of the service therefore enable a feasible estimate of the not so visible "knowledge capital" generated in specialist service provision to be derived. Additionally, funds generated and accounted for under the charitable trust fund at Papworth hospital (section 7.7) provide a stream of investment in the various dimensions of “knowledge capital” including "public health goods capital" and "capacity in health capital", thereby providing some proxy measures for this resource.

Papworth hospital's management team intuitively recognised the importance of the reputational benefits derived from such spillovers and continued to invest in the maintenance and development of the components of "knowledge capital" (section 7.6). Despite the NHS policies and performance framework working against such investments (section 7.6.1), the recognition of the value of such spillovers were very evident. The annual investment a specialist hospital makes in the overlapping "human capital", "relational capital" and "public goods in health" dimensions help systemise learning and generates new knowledge and "public goods" in their specialities. Some of these benefits spill over into the health system and society, which further add value to the stock of “relational capital” a dimension of "knowledge capital". There are increased returns from such capital (section 7.10), as the organisation gains a positive reputation for the provision of a specific speciality or a related speciality service and the development of skills and services. The funds thus generated are available for further investment in "human capital", "relational capital" and "tangible capital", thereby supporting the growth and maintenance of its “knowledge capital” and that of the health system.

This study estimated the stock of "knowledge capital" of the Papworth PH team as £1.53m (Table 7.21) at the end of the year 2005-06. An approach commonly used for measuring capital assets was adopted for this purpose. This estimate was based on the returns of £643k (Table 7.21) generated by the team over the seven year period between 2000 and 2007. Whilst the robustness of this valuation may be contested, the scale of such returns and its use to maintain and grow the stock of "knowledge capital" of the team and the hospital in general is not disputable. Scaling up, an estimate of £123.3m can be derived as the stock of "knowledge capital" of the hospital, based on the £7.4m non-clinical income of Papworth hospital, accounted in the year 2005-06 (Table 5.1). This estimate indicates that such assets can be significantly greater than the assets reported in the accounts at £50.2m (Papworth Foundation Hospital NHS Trust, 2006). Caution needs to be exercised in using these estimates as it requires to be counterbalanced with estimates of intangible liabilities (Harvey and Lusch, 1999). Any adverse impact on the organisation in terms of loss of reputation and trust when mistakes occur is not addressed in this study being outside its scope. The impact on the measure and value of "knowledge capital" in health in such instances based on the organisation's exposure to risk needs exploring in future studies.

7.11. Summary of case study

Summarising, this study highlights the co-generation of "knowledge capital" in health through the synthesis of qualitative data collected (section 7.2) using the model "knowledge creation cycle in health" (Chapter 4, 4.3). This resource is co-created by the sharing and capture of tacit and explicit knowledge into routines and systems of an organisation (Nonaka & Takeuchi, 1995) in the course of health service provision (section 7.2.5). The multi-dimensional and overlapping aspects of this resource in health namely, "human", "tangible", "relational/public goods in health" and "capacity in health" (Figure 7.4), are made somewhat visible through categorisation using "dimensions of knowledge capital in health" model (Chapter 4, 4.5). The challenges for measurement of this composite resource as an output arises as it exhibits "public goods" features in certain circumstances, spills over into the wider health system, and is not fully traded in the conventional sense (Teece, 2000; Lev at al. 2005).

The use of a joint economic accountancy approach, based on the cost of inputs of its joint production with specialised service provision (McPake et al., 2002; Drummond et al., 2005), provide a feasible start for the identification and measurement of this difficult to measure resource (section 7.3, 7.7). Using provider insight and cost data in context, this method makes a better informed estimation of value of inputs of its co-production in health service (McPake et al., 2002; Drummond et al., 2005). The challenges of disaggregation of joint resources are not fully resolved. Some progress nevertheless is made in the measurement of this difficult to measure resource by adapting a method for valuing capital assets that is in common practice (section 7.8)

Although this resource is not traded as an output in a conventional market sense its importance is intuitively recognised within an NHS hospital (section 7.6). Such recognition occurs because commercial and charitable bodies are providing funds to hospitals (section 7.7), dependent on their reputation for generating these knowledge based outputs. These funds are provided on the understanding that core clinical service is funded by the NHS (section 7.7). An estimate of the stock of "knowledge capital" derived in this study indicates that the scale of this capital is more than twice that of the tangible capital employed by the organisation (section 7.8). Nevertheless, there is no systematic management of this difficult to measure resource by health organisations or systems (Chapter 3, 3.5) despite being partly funded from the public purse. Additionally, wide access to some of these knowledge based resources is necessary for provision and development of health service (DH, 1998; Clarke and Wilcockson, 2002; Nicolini et al., 2008). The nature and scale of "knowledge capital" in health raises the importance of attempting to measure and manage the generation of this resource from a system wide perspective.

"Knowledge capital" in health is a significant composite intangible resource, which is co-produced with service delivery and research (Chapter 3, 3.3). The knowledge based nature of this asset raises the danger of it becoming obsolete and lost to organisations and health systems if not maintained through use. NHS financial and performance management policies do not recognise the scale and role of such asset development in health service provision. Additionally, policies that encourage competition within health systems could drive organisations to seek and develop resources that purely maximise organisational returns and not necessarily the health system. The recognition of "knowledge capital" generated in health service may enable the maximisation of the short and long term benefits in health systems overall.

The methods used for defining and measuring "knowledge capital" in this study require testing in secondary and primary health service settings, to take further measurement of this resource. An audit of the stock of "knowledge capital" in primary, secondary and specialist care providers in health could provide a better insight into the capacity and quality of service provision within the NHS.

The findings from the literature reviews and the case study in terms of the nature and scale of "knowledge capital" in health are combined in chapter 8. The implications for financial and performance management policies of provider and commissioner of services are raised by the findings of this study is highlighted. Further discussed is the need for health system policies to reconcile these different perspectives.

Chapter 8 Conclusion and Policy Implications

8.1.Introduction

This chapter summarises the findings of this study from literature reviews and empirical case study using models developed (Chapter 4, 4.3, 4.5). The implications, by the co-creation of "knowledge capital" in health aspects of which spillover into the health system and society at large, are discussed from the perspective of health service providers, commissioners and the NHS. This study attempts to motivate the identification and measurement of knowledge based outputs of health service provision in the NHS based on the concept of "knowledge capital" as developed in this study (Chapter 7, 7.10).

The aims and questions addressed in this thesis are related to understanding the nature and measurement of “knowledge capital” as a resource in health service provision. In answering the questions, a definition and measurement of "knowledge capital" in health as a resource is put forward, using a multidisciplinary approach that draws on an organisational, operational and strategic management perspective.

This enquiry, based on what key managers and stakeholders understand about resources used and created in health service provision, indicates the co-creation of “knowledge capital”, which includes additional dimensions of "public goods in health" and "capacity in health"(Chapter 7, 7.2, 7.6). Adapting data generated for management accounting purposes, measurements of this resource undertaken suit the purpose and need of use within a specialised health service centre. The methods undertaken though incomplete in capturing the true value of this resource make its measurement feasible through the visible proxy value as it crystallises.

Estimates of value of this capital derived within the context of its use, adapting capital asset pricing methods (Chapter 2, 2.5.1) that are in common use are more meaningful in practice (Chapter 7, 7.2). Building on earlier studies in other sectors (Chapter 2, 2.6), therefore, a feasible start is made at recognition and measurement of "knowledge capital" generated in health by the development of processes, skills and knowledge to improve health services provision.

8.2. Findings from literature review and empirical case study

The "knowledge creation cycle in health"(Chapter 4, 4.5) provides a framework for deconstructing the capture of patient's experiential knowledge, converted by the use of staff's conceptual knowledge into systemic and routine knowledge in health (Nonaka and Takeuchi, 1995; section 7.2). The sharing of tacit and explicit knowledge of patients and staff creates data, converts it into information and knowledge in the form of clinical symptoms, patient history and patient service activities (Figure 7.3, Chapter 7, 7.2) for the provision of effective and safe health service. This loop of knowledge creation progresses with each contact the service providers have with the patient (Chapter 7, 7.2), thus creating a knowledge spiral (Nonaka and Takeuchi, 1995). Furthermore, sharing of the knowledge and information gained leads to group knowledge by becoming embedded into the management systems and routines of the hospital.

The model, however, does not enable a view to be drawn on the robustness of review and quality control of knowledge generated that is shared and spills out of the organisation. As identified in earlier studies (Chapter 2, 2.6), and evidenced in this study (Chapter 7, 7.2, 7.8) the sharing of tacit and explicit knowledge by patients and staff in providing health services and the capture of such knowledge into routines and systems of the organisation generates this composite knowledge based resource (Nonaka and Takeuchi, 1995), namely "knowledge capital" in health.

This study finds the management processes in health service organisations include a spectrum of information and knowledge derived from deliberate processes such as multidisciplinary team meetings to embedded routine processes, such as admitting patients to the hospital (Figure 7.2, appendices 6, 7). Investments in such processes enhance the service provision and development knowledge base of the organisation and the NHS (Chapter 7, 7.2). The evidence gathered at Papworth hospital further reiterates the importance and interdependency of knowledge creation, capture and embedding into routines for safe health service delivery (Chapter 3, 3.5, Chapter 7, 7.2). One example is the process by which patient records are updated. A systematic review is required to ensure that the test results and procedures undertaken are updated in time to ensure that the latest information is on hand for service provision (Chapter 7, 7.2). Likewise, atrophy of some critical process knowledge within a health organisation can create a risk to safe service delivery if learning is not systemised and put into practice (Chapter 2, 2.5).

Further, this study observes that the process of documentation by the sharing and transfer of knowledge is an essential part of health service provision. This facilitates explicit learning from service provision which gets embedded into the management systems of the organisation (Chapter 7, 7.2). On the other hand some of the learning may have tacit components which may not get embedded, without which the implementation of learning may not be possible. Nevertheless, this systemisation of the knowledge generated provides the organisation with the skills and culture to assimilate new knowledge and co-produces "knowledge capital" in health (Chapter 7, 7.4). In addition, competitive new knowledge created for example as part of research projects in health service, contributes to the evidence base in health either through reinforcing the efficacy of current practice or highlighting gaps in systemic knowledge (Chapter 7, 7.8). There arises a need, however, on how the knowledge generated undergo quality control particularly those in patient groups which are outside organisational management.

The wider benefit of health knowledge generation observed in this study (Chapter 7, 7.2) is that such knowledge is used in practice as a result of service providers' involvement in its generation as suggested by Newell et al. 2003. Ownership of knowledge generated by those delivering health and social care therefore makes improvements to health service practice an integral part of service delivery (Newell, 2003, Chapter 7, 7.2). The implementation of such learning within the organisation expands the evidence base (Chapter 7, 7.9) in the health system, as patients and other health service personnel encounter the organisation and its staff.

Further, this study observes that in making tacit operational knowledge explicit certain parts of the data generated become a source of value for the organisation through repeated use of processes or insights gained (Chapter 7, 7.2, 7.7). Additionally, the culture of research increases the organisation's capacity to absorb new knowledge and thereby improve current practice (Cohen and Levinthal, 1989). On undertaking research, explicit review and documentation of current clinical practice and processes become part of the baseline setting process thus raising awareness of the current processes of service delivery (Chapter 7, 7.2). This increased awareness translates into improved quality control in both clinical and non-clinical service provision (Chapter 7, 7.2, 7.7). These health service organisations thereby attract research and additional funds to increase their research capacity. Meanwhile, by undertaking commissioned research, additional funds are generated together with the development of skills in the workforce and organisational capacity, which spillover into wider health systems (Chapter 3, 3.3).

Specialised health service hospitals in a health system, such as Papworth hospital, have the additional potential to deliver the benefit of generating explicit knowledge creating capacity or R & D capacity (Chapter 5, 5.3, Chapter 7, 7.7). Within the NHS the specialised providers are in effect the R&D pipeline of future health interventions (Chapter 7, 7.10). These hospitals act as a hub in the NHS from which new interventions are disseminated to the general hospitals and GPs, as interventions and procedures become more routine (Chapter 7,7.7). A simultaneous benefit is the enhancement of the hospital's reputation thereby attracting further research projects, grants and donations (Chapter 7, 7.7). In this way "relational capital", "public goods in health" and "capacity in health", all components of "knowledge capital" in health are generated.

Health economists recognise that health service provision creates additional benefits such as health knowledge and information, processes and public health benefits

(McPake et al., 2002). Attempts have been made to measure such benefits in the context of health research (Buxton and Hanney, 1996; Buxton et al., 2000; HERG et al., 2008) but not in service provision. The model "dimensions of knowledge capital in health" (Chapter 4, 4.5), in this study supports a categorisation and measurement of these benefits that spillover into the wider economy, namely "public goods in health" and "capacity in health" (Chapter 7, 7.6), as additional aspects of "knowledge capital" in health.

This study identifies the interrelated and overlapping components namely "public goods in health", "relational capital" and "capacity in health" (Chapter 4, 4.5) as the "public goods" component of "knowledge capital" in health. The "public goods" nature of some of these components means spillover of such resources into the health system and society impacts the reputation of the organisation and health system. Research and charitable funds attracted by a specialist centre (Chapter 7, 7.5), may therefore be best thought of as returns on the hospital's stock of "knowledge capital". Funders provide such funds based on the reputation of the organisation to deliver quality services and service developments, based on the understanding that core health service provision is funded by the NHS. From this perspective, such funds are interpreted as returns on the "knowledge capital" of the hospital.

Measurement challenges raised by the joint production of this resource are partly addressed through a management accountancy led approach of "bottom up" costing (Begg et al., 2008). The context of its creation thus provides a feasible basis for disaggregation of joint resource use and a measurement of these assets. This method provides a suitable base for the allocation of the value of inputs of joint production using the service provider's knowledge (Chapter 2, 2.5, Chapter 7, 7.3). Challenges of measurement (Chapter 3, 3.4) that are shared with knowledge and other "public goods" (Teece, 2000; Foray, 2004) are addressed by adopting economists and management accountants input pricing approach (Chapter 2, 2.5). Such an approach makes feasible, attempts to measure "knowledge capital" based on charitable funds generated as outputs.

These charitable funds that support the development of "knowledge capital" in hospitals, however, are accounted in NHS accounts by hospitals only when used and are not an integral part of the hospital's management systems. The absence of integration of the management of these funds in the light of the interdependency of its generation means tensions are created for health organisations. Such tensions arise in resource allocation decisions related to such investments and the trade-off between open and controlled access to the resources created (Chapter 7, 7.8). The necessity, therefore, arises for health system policies to incentivise health service organisations to invest in the generation of these resources with "public good" characteristics.

"Knowledge capital" in health as a resource can thus be seen as a subtle mix of competitive and non-competitive elements, raising difficulties for measurement and management. Earlier studies (Buxton and Hanney, 1996; Buxton et al., 2000) attempted the measurement of benefits from research or explicit knowledge creation from the health system perspective whereas "knowledge capital" is a resource generated in the course of service provision. Their work does not consider the capture, measurement and management of "knowledge capital" in all its forms as seen at Papworth or elsewhere in the NHS.

The challenges for measurement of this resource as an output stem from the lack of clear tangible identity, fuzzy boundaries of ownership and its non-excludable nature. A possible means to start addressing these challenges in health service is made feasible through deriving estimates of the value of this resource based on the costs of inputs of the joint production of health service and "knowledge capital". Using service provider insights in a "bottom up" costing approach provides a start for the identification, disaggregation and allocation of resources used in the joint production, to the extent possible. The additional costs in the provision of specialised health service compared with that of routine clinical service, thus provide an estimate of a value of the inputs for the co-produced "knowledge capital".

Funds generated from non-clinical activities, therefore, form a basis for estimating the stock of "knowledge capital" of Papworth hospital at a given point in time. An indicative estimate derived by using the 6% rate of return required within the NHS suggests that the scale of this intangible asset can be two and half times that of the tangible assets reflected in the hospital's NHS accounts (Chapter 7, 7.8.1). Papworth hospital's strategy to invest in the knowledge based outputs of health service provision to grow its stock of "knowledge capital" suggests that the organisation recognises the significance of such interdependency (Chapter 7, 7.7). The scale of this resource as estimated in this study suggests that it requires recognition in policy and measurement for constructing appropriate management and financial policies within health organisations and systems.

The evidence in this study suggests that the generation and use of "knowledge capital" as a joint and interdependent product of service provision is not as yet actively managed by the hospitals or policy makers in the NHS (Chapter 7, 7.10). Some aspects of this resource nevertheless spillover and impact the wider health system and society. There is a risk, therefore, of systematic undervaluation of health service and other outputs particularly in any potential market based solutions, which do not by their nature value "public goods".

A start at its measurement and management is required, therefore, in health policies so that both short-term efficiency and long-term health benefits are maximised. The implications of this for policy within a health system, both for providers and commissioners of health services and the reconciliation of perspectives, are discussed next.

8.3. Policy implications for providers of health services

The implications for providers' policies by the co-production of "knowledge capital" are considered in terms of strategic coordination, knowledge management, and patient education and communication, as this is a resource where trade-offs between open and controlled access require systematic management.

8.3.1 Strategic coordination

The concept of "knowledge capital" resonates differently with different functions of the organisation (Chapter 2, 2.3). Within an organisation, for example, human resource managers are interested in "human capital", contract managers with "relational capital", clinical and service managers in terms of "capacity to deliver health service" and "public goods in health". The human resources function relates to the training and staff development aspects that form the "human capital" elements of “knowledge capital”. Clinical and service managers have a greater interest in these skills and the capacity of the service team for delivering health services to meet performance targets, including financial ones, set within the NHS.

These multiple perspectives need strategic co-ordination and management as certain tensions arise among the disciplines in relation to various elements of “knowledge capital”. For example, as highlighted by the strategic team at Papworth hospital (Chapter 7, 7.8), organisations working with policies that drive towards efficiency measured as short run operational targets for service delivery face dilemmas as investments that develop the "human capital", "public goods in health" and "capacity in health" components yield returns over the long run. The measurement of "knowledge capital" may provide organisations with a framework to systematically consider and make visible some of the tradeoffs between long run and short run benefits of its management decisions (Chapter 7, 7.8). "Knowledge capital" as a composite resource, though not very visible, has a greater value than the tangible assets currently reported in the NHS accounts, an estimated in this study (Chapter 7, 7.10).

Factors considered as necessary within the policies of a specialist hospital for the development of an optimal return on "knowledge capital" include training of staff in all disciplines, multidisciplinary team working, reflective practices, and creating a research culture within the organisation (Chapter 7, 7.7). Management policies need to recognise, integrate and enable allocation of appropriate resources for the co-production of services and processes that develop competencies and knowledge. Furthermore, the full spectrum of benefits generated need to be explicitly identified and managed as "knowledge capital" in health. For example, the advantage in investing resources in the early stages of the generation of "public goods in health" provides privileged access to data for research and potential for building a reputation as innovators.

8.3.2 Knowledge management

A specialist hospital embeds co-creation, capture and dissemination of new knowledge as an integral part of service delivery (Chapter 7, 7.7.2). Innovation is regarded as integral to specialised health service provision with new knowledge creation and capture of such knowledge seen as core activities of the organisation (Chapter 7, 7.7). Such an ethos is not exclusive to the clinical activities but what was observed at Papworth hospital is that the support services and other disciplines also adopt this thinking. Though not explicitly stated, the strategy of this specialist hospital converged towards co-production of new knowledge and specialised clinical services with clear objectives for service delivery and knowledge creation (Chapter 7, 7.5).

By the convergence of strategies for research and service provision the need to monitor effectiveness of the generation, capture and dissemination of knowledge in service provision is recognised. To what extent policies within primary and secondary health service organisations that are directed towards operational targets need to recognise and value the creation and capture of learning in service provision requires further enquiry.

8.3.3 Patient communication and education

Patients and carers requiring specialised health services are provided with education about their condition and given support to encourage involvement in their care plans. Such education results in the generation of "public goods in health" such as expert patient contribution, the benefits of which extend both within the NHS and into other service sectors in the economy (Chapter 7, 7.2). Such an impact may also be true for many treatments provided in secondary care settings. As an example, education and housing staff understand more about health services through the involvement of social workers and the patient's contact with those services.

In some instances the benefits of such education could extend globally as staff and patients participate in patient and support groups that extend outside the original organisation. This is particularly so as information and communication technology makes it possible to disseminate and create patient networks that cross geographical boundaries. The impact of such practice on the quality of service delivery and "knowledge capital" generation in primary, secondary and community health service settings requires further research.

8.3.4 Summary of implications for providers

The co-production of service delivery and "knowledge capital" means from a health service provider perspective that policies on specialised service delivery, knowledge creation and management, human resources development and patient engagement are interdependent. Such interdependences are intuitively managed by research oriented specialist centres although performance management frameworks in health systems do not recognise this (Chapter 7, 7.6). Strategic co-ordination and convergence of service provision and knowledge creation or research is necessary in all hospitals including those which focus mainly on primary or secondary service provision.

In terms of measurement, NHS reporting requirements mean management and financial reports of NHS organisations can be adapted to estimate some of the additional costs of this co-production. As this study has found there is an underestimation (Chapter 7, 7.4) of the costs of additional outputs of providing a specialised service in the NHS. Specialist hospitals as R&D pipelines of the NHS could support the development of HRGs, resource profiles and tariffs that better reflect the resource use in specialised service provision.

Part of the cost of investment by such organisations in some aspects of "knowledge capital" such as "human capital" is recognised through training and R&D funds reimbursed by the NHS (Chapter 7, 7.5). The hospital and the NHS, however, gain privileged access to health data, a "public good", enabling the organisation to enhance its reputation for research which translates into "relational capital". At the time of this study the "capacity in health" and the "public goods in health" generated by these organisations, however, are not adequately recognised and financed by the NHS.

Policies such as the R&D levy funding and Foundation Trust status are perceived by the specialist hospital in this study as being supportive of the formation of "knowledge capital" (Chapter 7, 7.5). The NHS performance framework is seen as unhelpful (Chapter 7, 7.6) as it monitors health service organisations against non-financial targets. These include access to service, patient satisfaction, board capability and so on (Chapter 5, 5.3), in silos of service provision and development of knowledge and skills without recognition of their interdependency (Chapter 5, 5.3). Again the Payment by Results regime, geared towards efficiency based on average prices, works against investment of resources for "knowledge capital" generation in NHS hospitals (Chapter 7, 7.5).

"Knowledge capital" could provide hospitals with an integrated framework for measuring the full spectrum of outputs from service provision, research and development of skills, knowledge, capacity and improved services.

8.4. Policy implications for commissioners of health services

The interdependency and joint production of services and "knowledge capital" in health raises challenges for commissioners of health services in terms of resource allocation and performance management that maximises the long and short term health benefits. For safe health service provision requires the development of health knowledge, skills and knowledge based resources, which can be evaluated and disseminated widely within the health system. From a health system perspective, therefore, commissioners have an interest in developing more widely accessible "public goods in health" and "capacity for health" components of "knowledge capital" together with service provision. Health service providers on the other hand may be reluctant to invest in the development of such resources because in part such resources are not technically excludable or controllable by the organisation. .

From this study, it is clear from a health system perspective such as the NHS that the structure for performance management and resource allocation needs to improve the recognition of the interdependent production of services (Chapter 7, 7.6). Attempts to measure "knowledge capital" in health are required to enable appropriate investment in knowledge based resources. For example, resource allocation in the shape of average prices for specialised health services in the NHS needs to recognise the full range of resources required for the joint outputs of service and "knowledge capital" (Chapter 7, 7.5).

The tariff for specialist services therefore needs to be higher than the speciality average to reflect the additional output of capacity to create new knowledge and services. Another option by which to give recognition to the joint production would be to develop separate standard HRG tariffs with underlying resource profiles for the clinical care aspects of these services. A separate payment could then be considered as acknowledgement of the additional outputs of research, capacity to create new knowledge and service developments. If not, the risk arises of hospitals investing in the competitive aspects of the resource namely "relational capital", through commercial research projects, rather than "public goods in health" or "capacity in health", the non-competitive components of "knowledge capital".

NHS policies on the funding and management of R&D, currently managed centrally, need to recognize the interdependence of health service delivery and research in conjunction with commissioning service provision (Chapter 5, 5.3). Research capacity in health service organisations is created through the accumulation of learning derived from reflective practices such as team meetings and study days amongst others (Chapter 7, 7. 2), which may be lost in an efficiency driven environment. This is particularly so where average prices or market based solutions that do not value all the outputs of joint production are used to drive efficiency without the safety net of a performance management framework that recognises the co-creation of "knowledge capital" in health.

Specialist hospitals need recognition for their capacity to generate such knowledge and their role as a knowledge hub within health systems. . Performance management using "knowledge capital" as a framework may help to hold such hospitals explicitly accountable for the generation and dissemination of new knowledge and development of capacity for health service (Chapter 7, 7.7). In this way, these aspects become an integral part of such hospital’s performance targets set by the NHS. Development of such policies informed by the concept of "knowledge capital" may be a mechanism for recognising and managing the interdependency of health service provision and the creation of health knowledge.

At the practical level, developing a mechanism for organisations to define, recognize and value the knowledge based resources created in the course of health service delivery can support the maintenance and development of "knowledge capital", including the research capacity, of the health systems. An estimate (Chapter 7, 7.10) indicates that the stock of "knowledge capital" of health organisations may well be significantly greater than the assets that are explicitly managed. "Bottom up" costing of services provides commissioners with costs that can be audited and comparable across the NHS, as a start. Furthermore, including accounting categories specifically for "knowledge capital" could provide commissioners of clinical service provision and research with a performance management framework which recognises both tangible and intangible outputs of health service provision. This in turn helps to better inform policies that aim to achieve the optimal investment path that maximizes health benefits.

8.5. Reconciliation of the provider and commissioner perspectives

What was observed in this study is that in a health system there are potential tensions between the perspectives of the service provider and the commissioner (Chapter 7, 7.8). In this context, the use of "knowledge capital" as a framework can help highlight the overlap of perspectives. The service provider's perspective is mainly organisational, aiming to produce maximum returns for the organisation through service provision using accessible resources. The commissioners in the NHS, on the other hand, implement policies aiming to maximise health benefits to the health economy (Chapter 5, 5.3).

In the NHS, for example, there is a drive for health services to be provided in the community where possible, in a setting closer to patients, rather than in an expensive hospital setting (DH, 1989, 1991, 2006c). The commissioner perspective may suggest such a policy to be a cost efficient option, whereas from a specialist hospital perspective this could be seen to spell a loss of revenue, at least in the short run. The equation, however, changes when considering the loss of the wider benefits to patient care and health systems that derives from the interaction between specialised health staff and the pool of patients with a relatively rare health condition. Specialised services commissioning policies, therefore, aim in part to support the investments in processes for development of skills, knowledge and services in such conditions.

Specialist hospitals support and require a cohort of patients for research, and development of skills and services (Chapter 5, 5.3.4). Through supporting such a small cohort, expert patients are developed and their contribution is captured for development as "public goods in health". Policies which recognise the "public goods" element of "knowledge capital" could in the long run, potentially enhance the shift of service delivery into different settings within the health system. Such shifts in service delivery may happen naturally as emerging treatments are developed and specialist services become routine secondary services.

It was observed in this study (Chapter 7, 7.2,7.7), that through investing in processes for the sharing of knowledge between health organisations appropriate depths of knowledge and skills for delivery of aspects of the treatment were simultaneously developed in community and primary care settings. The intangible benefits of development in "capacity for health" resulting from such transfer of specialist knowledge and process learning is accessible to the wider health system. A system wide "knowledge capital" framework can shed light on the generation and measurement of such benefits from a health system perspective, which can better inform the management of such assets. Additionally, it would provide policy makers with a mechanism to address the balanced resourcing of the development of knowledge based resources that could deliver long term benefits.

Commissioners of specialised services and research need to recognise that research and service development capacity is co-produced with the provision of these services (Chapter 7, 7.7) and may be systematically under resourced especially when service costs are squeezed by efficiencies. This is particularly so as the inputs of the joint production are not always clearly visible and divisible between such outputs and service provision. The difficulties of disaggregating costs between research and service delivery in the NHS have long been recognised (Culyer, 1994). Mechanisms to understand and measure the resources utilised for joint production of "knowledge capital" with service provision therefore become important, both from an organisational perspective and that of the wider health system. The management accountancy led "bottom up" approach of costing of resources could enable the disaggregation, to some extent, and estimation of the costs of inputs for the co-production of such services and "knowledge capital" (Chapter 7, 7.3).

The pharmaceutical industry has long tapped into the "knowledge capital" of hospitals and health systems through funding and undertaking clinical trials, which capture experiential knowledge (Chapter 4, 4.3) embedded within hospitals as highlighted earlier by Culyer (1994). By commissioning research in hospitals pharmaceutical organisations support the development of skills and capacity for research in different therapeutic areas (Chapter 3, 3.3, Chapter 7, 7.6). However, if health service providers are left no option but to source investment for activities that generate "knowledge capital" from commercial organisations, the important non-competitive elements of health knowledge may get crowded out. Such crowding out could lead to a lack of development in "public goods in health" and "capacity for health" in areas of priority for the NHS.

The UK government's intention, from a health system perspective, is to create a patient led service with patients informing the choice of providers for treatment (DH, 1989, 2006a, 2010). Such intentions could have a better chance of being converted into practice if the strategies of hospitals in the NHS and the policies of the Department of Health explicitly recognise the role and value of knowledge derived from patient experiences, as part of the "knowledge capital" in health (Chapter 7, 7.3). When experiences of patients receiving health services are not captured and embedded for use within organisational systems and routines, patient safety can be compromised.

In the long term, such lapses may create disbenefits leading to some loss of confidence in the organisation and potentially the wider health system (Chapter 3, 3.6). In other words, the "reputational capital" and "public goods in health capital", both of which are components of "knowledge capital" of the health system, could atrophy. Yet if learning gained from the experiences of health service delivery is captured and used effectively such knowledge forms the basis for generating new knowledge and creates different aspects of “knowledge capital”. This in turn can potentially generate additional funds for reinvestment within the organisation and the health system. However, the porous nature of "knowledge capital" raises tensions for resource allocation decisions within hospitals (Chapter 7, 7.6), particularly as some of the outputs of the joint production are not fully divisible and excludable.

A framework of "knowledge capital" audits or statements, it is argued, could provide a mechanism for organisations and health systems to shed light on the overlapping benefits generated from service provision. The commissioner and provider perspectives can thus be brought together to begin to reflect the broader benefits. Particularly pertinent are benefits derived in the shape of "human capital", "capacity for health" and "public goods in health", which need recognising in integrated health system policies as discussed further.

8.5.1 "Human capital"

Tensions are generated when specialist hospitals invest in generic training for staff. Staff are attractive to other organisations, within both the NHS, the private sector and other countries when the skills gained are more generic. At the same time specialist hospitals gain from investments made by other organisations as trained staff join the organisation to acquire specialist skills (Chapter 7, 7.6). In the NHS, some of the costs of training are reimbursed by the Deanery, but not all the costs are covered (Chapter 7, 7.3). Health organisations investing in training may often not be able to reap the full benefit of the investment of training as staff move to other organisations.

Staff moving from one organisation to another, nevertheless, refer back to their specialist hospital contacts to resolve queries of technical know-how in their new organisation (Chapter 7, 7.7). Such informal transference of knowledge tends to enhance the reputation of the specialist hospital as a centre of excellence and technical knowledge within the local and global health systems. Insufficient training of staff, however, can raise the risk of creating a negative reputation through errors, as the treatments provided in specialist centres are often emerging. In this way, "human capital" straddles health organisations and systems adding to the capacity for health service provision. This therefore requires to be addressed from a health system perspective.

8.5.2 "Capacity in health"

Health systems acquire an increased skills pool and capacity for health service provision as a result of investment in training and the experiences gained by staff in organisations. At the same time the organisations investing in staff training gain residual benefits in the form of routines, processes and systemic knowledge resulting in improved "capacity in health" (Chapter 4, 4.5), an aspect of "knowledge capital" in health. An organisation investing in staff training can increase its reputation within the health system as a nurturing and skills development organisation, attracting the next generation of specialised health service staff (Chapter 7, 7.7). Activities such as GP study meetings that disseminate new health knowledge created in a specialist hospital potentially enhance GPs' diagnostic skills thereby increasing the knowledge base of primary and secondary health services staff. Additionally, such study meetings can initiate increased demand for specialist services.

Through the development and transfer of knowledge by specialist centres the knowledge base of the health system is developed, thereby increasing the "capacity for health" in the NHS. Such activities simultaneously enhance the reputation of the staff and the hospital as a centre of excellence that translates into "reputational capital", another aspect of "knowledge capital". Here again the health system has an important role in orchestrating such developments through its policies.

8.5.3 "Public goods in health"

Investments made by organisations in "human capital" can enhance the health services provided to patients by developing skills, education and involvement of patients and carers. Besides improving quality of service provision, such education and involvement in provision of care for chronic conditions potentially generates new knowledge or reinforces current understanding of a health condition. Such increased understanding helps create expert patients in these health conditions, resulting in the "public goods in health" aspect of "knowledge capital" in health. The sharing of experiences of patients and carers transcends geographical boundaries especially in the internet era with increased access to such knowledge through technology. When reviewed and managed these forums thus become an additional "public resource" for the understanding and development of health services for these conditions as they are accessible to the wider health system and society as a whole.

As found in this study (Chapter 7, 7.2), an organisation providing specialised health services recognises the importance of capturing and learning from patient experience and invests in developing patient newsletters, patient groups and so on (Chapter 7, 7.7). Although the NHS performance management policies do not reward such activities, the organisation sees investing in such activities, which form the "public goods in health" component of "knowledge capital" of the organisation, as important. Further research into the nature, role and importance of patients' experiential knowledge for health service provision, as indicated in chapter 7, 7.10, may further help clarify the benefits to the health system of the "public goods in health" dimension of "knowledge capital".

8.5.4 Summary of policy implications for health systems

Summarising, the joint production and interdependency between new knowledge creation and health service provision requires recognition at the health system level. The UK government recognises that in economic terms knowledge creation can be a joint product (externality) of health service delivery, but the delivery of health service and knowledge creation of organisations are managed in separate silos in the NHS (Chapter 5, 5.3). The Department of Health needs to recognise the additional challenges posed by the current policies for health organisations in the context of joint and interdependent production of services and "knowledge capital". These are challenges in addition to what is already understood to be an issue such as funding, teaching and research costs.

A NHS performance management framework using the concept of "knowledge capital" in health could help account for both visible and these less visible knowledge based outputs of service provision. Charitable funds generated by hospitals through their reputation support generation of invisible outputs, such as skills and processes that develop health services. These funds are currently reported separately to the Charities Commission. Such data as used in this study could serve as a metric for measuring "knowledge capital" in a health service organisation (Chapter 7, 7.7).

Some of the perils of not recognising the interdependencies between the "human capital", "relational capital", "public goods in health capital" of "knowledge capital" and health service delivery are highlighted by this research (Chapter 7, 7.10). For instance, policies that encourage competition within a health system can drive organisations to seek and develop resources that maximise returns mainly for themselves, such as commercial research, at the expense of capturing learning or generating these resources that are required within the health system as a whole.

Health service policy needs to take into account the wider benefits of service provision as a whole rather than to develop independent policies for clinical services, skills and service development and research provision by hospitals. To ensure effective and safe health service provision health system policies need to recognise the co-creation of "knowledge capital" in health and the synergy created by the collaborative working of the organisations in the health network. An estimate derived in this study suggests that such assets may well be of greater value than the value of tangible assets (Chapter 7, 7.7) currently managed and accounted for by organisations within the NHS. This raises the danger of organisations placing a greater emphasis on research reputation at the expense of service developments.

The impact on the existing stock of "knowledge capital" in health needs clarification as the NHS shifts towards funding based on nationally determined uniform prices using HRG tariffs, or any market based solution, which does not recognise the "public goods" aspects that are generated. In addition, resource allocation policies need to factor in aspects such as multidisciplinary working, staff development through experiential learning and the maintenance and use of existing processes, which create and disseminate new knowledge (Chapter 7, 7.7). The lack of recognition for knowledge creation and dissemination as an integral part of service delivery, within the main NHS performance framework, means this aspect is in danger of being ignored by organisations when funding becomes tight. Such danger is identified in this study by those managing a health service organisation (Chapter 7, 7.7). The monitoring of hospital charitable funds separately, without linking the stock of "knowledge capital" that is developed and maintained within the hospital, means the greater intangible resource may be managed to priorities not aligned to those required in the NHS.

8.6. **Further research questions**

In order to provide a balanced view on the value of "knowledge capital" in an organisation, estimates need to be developed for "knowledge liabilities" based on the potential risk exposure of the organisation. The applicability of the “knowledge capital” framework and models needs testing in organisations that deliver primary, secondary and community health services. Such testing may highlight the scope and scale of “knowledge capital” generated in the delivery of established treatments in health services.

The extent to which “knowledge capital” generation is taken into account in the economic evaluation of health service policies needs further study. The impact on economic growth by the stock of "knowledge capital" within a health system, particularly “public goods in health” and “capacity in health” dimensions of the capital, needs further research. The significance of these two components on the quality of service provision needs further exploration. The question of who should pay for the creation of knowledge capital and which component parts should be invested in and by whom, needs further investigation, particularly given the scope and long term nature of the benefits generated.

8.7. Conclusion and recommendations

“Knowledge capital” co-produced with health service provision is an important resource both from an organisational perspective and that of the wider health system. Whilst the NHS has a long-term commitment to investing in research and evidence based health service delivery, separate policies and management of the creation of accessible new knowledge or research and service delivery work against such objectives (Chapter 7, 7.10).

Furthermore, there exists a danger, in a drive to fund services on the basis of uniform and average prices for service, that the generation of “knowledge capital” in health may be under resourced and depreciate if such assets are not explicitly managed. Efficiency targets are geared towards short run benefits whilst the benefits of "knowledge capital" are generated over the long run and increase in value with use. NHS resource allocation policies and performance management thus need to surface and recognise the joint and interdependent production of health services and "knowledge capital". In this way the tangible and intangible outputs can be maximised by the health system for sustaining a knowledge-based health service.

This study makes a start on the identification, allocation and cost estimation of "knowledge capital" as a resource generated in health service (Chapter 7, 7.5) with the disaggregation and quantification of the component parts requiring further exploration. Funds generated as charitable funds from non-patient related activities provide a starting point for surfacing and estimating the returns generated from the embedded stock of "knowledge capital" of a health organisation (Chapter 7, 7.8). A start on the definition and measurement of "knowledge capital" in health (Chapter 7, 7.8) using existing reporting mechanisms could help create better informed management and resource allocation decisions for both specialised service provision and generation of knowledge based assets in health.

Recommendations

The findings of this study highlight a need to integrate the performance management of service delivery, education and knowledge creation to reveal the tradeoffs made in service provision in terms of the short-term and long-term benefits of the joint outputs. Integrated policies and structures for the management of health service provision, education and research are recommended to policy makers. "Knowledge capital" provides a framework for the recognition and integrated management of such knowledge based resources that are essential in health service provision.

Furthermore, "knowledge capital" as a framework may support the reconciliation of the provider and commissioning perspectives of health service and research to achieve the short and long run objectives in a health system. A review of clinical charitable funds is thus recommended as an indicator of the reputation of the teams for providing and developing quality services.

The testing of this methodology is recommended, to estimate the value of "knowledge capital" of primary and secondary care health organisations as part of an audit of the stock of the "knowledge capital" within the NHS. Funds generated through non-patient care outputs can as a start serve as a monetary measure of returns on the organisation's stock of "knowledge capital".

Evidence from this study makes the case for using "knowledge capital" as an overarching framework for integrating the creation of knowledge based assets into the performance management of health service organisations. As a practical start, an audit of the stock of "knowledge capital" of organisations within the NHS is recommended.

Acknowledgements

This study was made possible by the foresight, support, advice and encouragement of a number of people. I would like to thank: Charles Normand for seeing the importance of the topic without which this project would not have started and his generous and patient support, encouragement, advice, valuable discussions and comments that enabled completion of this project; Miranda Mugford for her support, advice and generosity in providing detailed and considered comments on the various drafts; Richard Fordham for his help and support particularly for taking on primary supervision midway in this endeavour; Pinar Guven for support, advice and teaching opportunities that enabled presentation of some of the findings of this study; Stephen Donaldson for agreeing and supporting the project as director of finance of Papworth hospital; Jane Payling on continuing to support the study on her assumption of the role at Papworth hospital; The executive directors and Michael Simmonds of Papworth hospital for being generous with their time and sharing their thoughts; Claire Tripp, Joanne PekeZaba, Bronwyn Ramsay and Rosemary Thornton at Papworth Hospital for their support and cooperation during the study at the hospital; Sally Warrell in reading the first drafts; Carol Perry for helping boost my morale with her generous and patient reading and rereading of the numerous drafts of this work. Finally, I would like to thank my family for their forbearance, love and support during this enterprise, and my mother and late father for engendering in me the strength of character to persevere in my endeavours by the example they set.

Glossary of terms

Break-even: Year on year revenue is sufficient to meet outgoings that are properly chargeable to revenue accounts**.** NHS trusts have to achieve a break-even position over a three year rolling period.

CRL: Capital Resource Limit – limits the amount of capital expenditure an NHS trust can incur in the financial year.

Codified knowledge: Knowledge codified for transference, such as blueprint, formulas or computer codes.

Connective Tissue Disease: Diseases of connective tissue which is the material inside your body that supports many of its parts and helps some of the tissues do their work. Cartilage and fat are examples of connective tissue.

(www.nlm.nih.gov/medlineplus/connectivetissuedisorders.html

CT scan: Computed tomography scan

DEL: Departmental Expenditure Limit

EFL: External Financing Limit – mechanism to assist in the control of cash expenditure by the NHS trust. The limit on the cash that a Trust can spend in a year, which is not generated by its operations, often closely linked to cash required for funding capital schemes.

Externality: Consumers and producers either are not affected or do not bear the full effects of their consumption or production. (McPake et al., 2002)

FT: Foundation Trust – Independent public benefits corporations created by the Health and Social Care (Community Health and Standards) Act 2003.

Global Public Goods in Health: Public goods in health with cross country externalities, such as health knowledge & technologies in health & policy & regulatory regimes of health systems. Consequently, it is irrational to exclude individual nations from consumption even if that nation does not contribute to finance such goods. Examples: interventions to improve health internationally, or prevent communicable diseases.

Goodwill: goodwill can include the trading reputation, patents, trade names, know how etc. and difficult to establish until the business is sold.

HRG: Health Resource Groups, a clinical activity data classification used for service planning, costing and commissioning in the NHS. http://www.ic.nhs.uk

MRI: Magnetic Resonance Imaging

MDT: Multi disciplinary team

Monitor: Independent regulator of NHS Foundation Trusts

Non–Excludable: Means that it is not possible to exclude non-payers from enjoying the benefits of the good, e.g. environmental health services

Non-Rival: One person's consumption of a good does not prevent another from also consuming the good, e.g. Public Health, education.

NHS Trust: National Health Services Trust

NSCAG: National Specialised Services Commissioning Advisory Group

PAS: Patient Activity System, a database to capture service activity by hospital in the NHS. Replaced by Patient Level Information and Costing System (PLICS)

PCT: Primary Care Trust

Portal Hypertension: is increase in pressure in the blood vessels carrying blood from the digestive organs to the liver.

Private Good: Goods that are excludable and rival in consumption that is consumption by one precludes or reduces the value for subsequent consumption.

PSA: Public Service Agreement agreed by government departments as part of their objectives for expenditure plans with the Treasury.

Public Good: Goods once provided, benefits are non-rival and non-excludable.

Public Goods in Health: Externalities yielding improvements in health in the country or globally e.g. prevention of communicable diseases

RAB: Resource accounting and budgeting.

Spillover: Costs or benefits that arise from an economic activity that are not taken into account by producers but borne or consumed by society.

Tacit Knowledge: Knowledge that is difficult to articulate in a manner that is meaningful and complete.

Value in use: The present value of future cash flows obtainable as a result of an asset's continued use, including those resulting from its ultimate disposal. (ASB, 1997; IASB, 2009a)

Bibliography

Accounting Principles Board (APB) (1970) Opinion 17, Intangible Assets. New York. American Institute of Certified Public Accountants.

Accounting Standards Board (ASB) (1997) FRS 10: Goodwill and Tangible Assets. London.

Andriessen, D. (2004) Making Sense of Intellectual capital-Designing a method for valuation of intangibles. Elsevier Butterworth- Heinemann: Amsterdam; London.

Audit Commission (2004) Introducing Payment by Results: Getting the balance right for the NHS and taxpayers. Audit Commission: London.

Audit Commission (2006) Audit commission review of the NHS financial management and accounting regime: A report to the Secretary of State for Health. Audit Commission: London.

http://www.audit-commission.gov.uk/Products/NATIONALREPORT/F27AD3E2-7FF4-4cdd-BB92-DF5C4BDD18FF/ReviewoftheNHSFinancialManagementandAccountingRegime25July06REP.pdf

Audit Commission, National Audit Office (NAO) (2008) Financial Management in the NHS: Report on the NHS summarised accounts 2007-08: London.

http://www.nao.org.uk/publications/0809/nhs_summarisedaccounts07-08.aspx

Baker, J. (1999) "Creating knowledge creating wealth" realizing the economic potential of public sector research establishments. A report to the minister for science and the financial secretary to the treasury. HMSO: London.

Begg, D., Fischer, S., Dornbusch, R., (2008) Economics. 9th edition, McGraw Hill: Maidenhead.

Black, N. (2003) Secondary use of personal data for health and health services research: why identifiable data are essential. Journal of Health Services Research & Policy 8(S1), 36-40.

Blacker, F. (1995) Knowledge, knowledge work and organizations: An overview and interpretation. Organization Studies 16(6), 1021-1046.

Bontis, N., Dragonetti, N.C., Jacobsen, K., Roos, G. (1999) The knowledge toolbox: a review of the tools available to measure and manage intangibles resources". European Management Journal 17(4), 391-402.

Bontis, N. (2002a) Intellectual Capital: An exploratory study that develops measures and models. The Strategic Management of Intellectual Capital and Organizational Knowledge, edited by Choo, C.W., Bontis, N. Oxford University Press: New York.

Bontis, N. (2002b) Managing Organisational knowledge by diagnosing intellectual capital: Framing and advancing the state of the field, The Strategic Management of Intellectual Capital and Organizational Knowledge edited by Choo, C.W. &. Bontis, N. Oxford University Press: New York.

Braunerhjelm, P. (2000) Does knowledge investment increase profitability?, Economics of Science, Technology and Innovation: Knowledge Capital and the "New Economy" Firm Size, Performance and Network Production. Chp.3, 37-52. Kluwer Academic Publishers.

Brennan, N., Connell, B. (2000) Intellectual Capital: current, issues and policy implications. Journal of Intellectual Capital 1(3), 206-240.

Brooking, A. (1996) Intellectual Capital. International Thomson Business Press: London.

Buiges, P., Jacquemin, A., Marchipont, J. (2000) Competitiveness and the Value of Intangible Assets. Edward Elgar Publishing Ltd

Bukh, P.N., Larsen, H.T., Mouritsen, J. (2001) Constructing Intellectual Capital statements. Scandinavian Journal of Management 17, 87-108.

Burton-Jones, A. (1999) Knowledge Capitalism Business, Work, and Learning in the New Economy. Oxford University Press, New York.

Buxton, M., Hanney, S. (1996) "Assessing payback on the investment in research". The Scientific Basis of Health Services (editors) Peckham, M. and Smith, R. BMJ Publishing Group.

Buxton, M., Hanney, S., Packwood, T., Roberts, S., Youll, P. (2000) Assessing Benefits from Department of Health and National Health Service Research and Development. Public Money and Management 20(4), 29-34.

Canadian Institutes of Health Research: (CIHR) (2002) Working Group on Case Studies. Case Studies involving secondary use of personal information in health research. Ottawa. http://www.cihr-irsc.gc.ca/e/pdf_15568.htm

Cañibano, L., Covarsí, M.G., Sánchez M.P. (1999) The value relevance and managerial implications of intangibles: a literature review. MERITUM Project.

Chartered Institute of Management Accountants (CIMA) (2001) Technical briefing - Managing the intellectual Capital within today's knowledge- based organizations.

Choo, C.W., Bontis, N. (2002) Knowledge, Intellectual capital, and Strategy – Themes and Tensions, The Strategic Management of Intellectual Capital and Organizational Knowledge edited by Choo, C.W., Bontis, N. Oxford University Press: New York.

Clarke, C.L., Wilcockson, J. (2002) Seeing need and developing care: exploring knowledge for and from practice. International Journal of Nursing Studies 39, 397-406.

Cohen, W.M., Levinthal D. A. (1989) Innovation and learning: the two faces of R&D. The Economic Journal September.

Covell, C.L. (2008) The middle range theory of nursing intellectual capital. Journal of Advanced Nursing 63(1), 94-103.

Cresswell, J. (1998) Qualitative inquiry and Research Design. Sage.

Culyer, A. (1994) Supporting Research and Development in the NHS - A report to the minister of health by a research task force. HMSO: London. http://www.doh.gov.uk/research/rd3/pub/docs/doh/culyer11.pdf

Currie, G., Suhomlinova, O. (2006) The impact of institutional forces upon knowledge sharing in the UK NHS: The triumph of professional power and the inconsistency of policy. Public Administration 84(1), 1-30.

Currie, G., Waring, J., Finn, R. (2008) The limits of knowledge management for UK public services modernization: the case of patient safety and service quality, Public Administration 86(2), 363-385.

Danish Trade and Industry Development Council (DTIDC) (1997) Intellectual capital Accounts, Reporting and managing intellectual capital Memorandum.

Danish Agency for Trade and Industry (DATI) (2000) A guideline for intellectual capital statements - A key to knowledge management.

Danish Agency for Trade and Industry, (DATI) (2003) Intellectual Capital Statements: The New Guideline.

de Geus, A. (1997) The living company, growth, learning and longevity in business. Nicholas Brealey Publishing Ltd: London.

Department of Health (DH) (1989) Working for patients. HMSO. London.

Department of Health (DH) (1991) The Patient's Charter. HMSO. London.

Department of Health (DH) (1997) Strategic Framework for the use of NHS R&D levy. NHS executive. HMSO. London.www.dh.gov.uk/en/Publicationsandstatistics/.../DH_4009827

Department of Health (DH) (1998a) Circular on criteria for defining Specialist services. HSC1998/198. London. http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Healthservicecirculars/DH_4003878

Department of Health (DH) (1998b) A first class service: Quality in the new NHS. HSC1998/113. London.

Department Of Health (DH) (1999) The NHS performance assessment framework, HSC1999/078. London. http://www.open.gov.uk/dh

Department of Health (DH) (2000) A health service of all talents: developing the NHS workforce: consultation document on the review of workforce planning. London.

Department of Health (DH) (2001a) Building a Safe NHS for Patients. The Stationery Office. London. http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_098565.pdf

Department of Health (DH) (2001b) National Specialised Services: Definition set No 29 Specialised Respiratory Services. http://www.dh.gov.uk/en/managingyourorganisations/commissioning/commissioningspecialisedservices/specialised services definition/dh_400171

Department of Health (DH) (2002a) Learning from Bristol: the department of health's response to the public inquiry into children's heart surgery at the Royal Bristol hospital 1984-1995. London.

http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4002859

Department of Health (DH) (2002b) Assessing a proposal to remove a dual accounting burden on NHS charities: Consultation. The Stationery Office: London.

Department of Health (DH) (2002c) NHS Foundation Trust: eligibility criteria and timetable. London.

Department Of Health (DH) (2002d) Reforming NHS Financial Flows, Introducing Payment by Results. London.

Department of Health (DH) (2003a) UK National pulmonary hypertension services: standards of care. London.

Department of Health (DH) (2003b) Payment by Results: Technical Papers July 2003 Review of Levies – Progress Paper.

Department of Health (DH) (2004a) Practice Based Commissioning: Engaging Practices in Commissioning. London. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4090357

Department of Health (DH) (2004b) Practice Based Commissioning: Promoting Clinical Engagement. London. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4098564

Department of Health (DH) (2005a) NHS Costing Manual. 2005 edition. London. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4113531.

Department of Health (DH) (2005b) Best Research for Best Health: A New National Health Research Strategy - The NHS contribution to health research in England: a consultation. http://www.dh.gov.uk/Consultations/LiveConsultations gateway ref: 5221.

Department of Health (DH) (2005c) A Short Guide to NHS Foundation Trusts. HMSO. London. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4126013

Department of Health (DH) (2006a) The NHS in England: the Operating Framework for 2006/7. DH gateway ref 6054: London.

Department of Health (DH) (2006b) Best Research for Best Health: A new national health research strategy. HMSO: London. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4127127

Department of Health (DH) (2006c) A Stronger Local Voice: A framework for creating a stronger local voice in the development of health and social care services. A document for information and comment.

Department of Health (DH) (2007a) National Commissioning Group (NCG) & National Specialised Commissioning Group (NSCG). http://www.dh.gov.uk/en/Managingyourorganisation/Commissioning/DH_076870

Department of Health (DH) (2007b) Private Finance Initiative (PFI), PFI guidance generic economic model. First published in 2003. London.

http://www.dh.gov.uk/en/Managingyourorganisation/NHSprocurement/Publicprivatepartnership/Privatefinanceinitiative/GenericeconomicmodelPFIschemes/DH_4016193

Department of Health (DH) (2007c) NHS Costing Detailed Guide to Costing for Commissioners. http://www.dh.gov.uk/en/Policyandguidance/Organisationpolicy/Financeandplanning/NHScostingmanual/index.htm, gateway ref: 9006

Department of Health (DH) (2008a) NHS Costing Manual 2007/08. http://www.dh.gov.uk/en/Policyandguidance/Organisationpolicy/Financeandplanning/NHScostingmanual/index.htm, gateway ref: 9367

Department of Health (DH) (2008b) Developing the NHS performance Regime

http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_085216.pdf

Department of Health (DH) (2010) Equity and Excellence: Liberating the NHS. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_117353. gateway ref: 14385 accessed on 22 July 2010.

Department of Trade and Industry (DTI) (2006) "Science and Innovation Investment Framework 2004-2014: Next Steps." pp35 HMSO: Norwich. U.K.

Drucker, P. (1993) Post Capitalist Society. Harper Business: New York.

Drummond, M.F., O'Brien, B., Stoddart, G.L., Torrance, G.W. (2005) Methods for Economic Evaluation of Health Care Programmes, 2nd ed. Oxford University Press: Oxford.

Drury, C. (2006) Cost and Management accounting. Thomson Learning. London.

Dzinkowski, R. (2000) The measurement and management of intellectual capital: an introduction-international management accounting study. Management Accounting.

Edwards, J.S., Collier, P.M., Shaw, D. (2005) Research report: knowledge management and its impact on the management accountant. Chartered Institute of Management Accountants. London.

Edvinsson, L., Sullivan, P. (1996) Developing a model for managing intellectual capital. European Management Journal 14(4), 356-364.

Edvinsson, L. (2002) Corporate Longitude – What you need to navigate the knowledge economy. Financial Time. Prentice Hall.

Ferlie, E., Wood, M. (2003) Novel modes of knowledge production? Producers and consumers in health services research. Journal of Health Services Research Policy 8(S2), 51-57.

Fitzgerald, L., Dopson, S., Ferlie, E., Locock, L. (2005) "Knowledge in action", Knowledge to Action? - Evidence-Based Health Care in Context, Oxford University Press, chp. 8, Oxford. Oxford Scholarship Online. Accessed 11 April 2011 <http://dx.doi.org/10.1093/acprof:oso/9780199259014.001.0001

Foray, D. (2004) The economics of Knowledge - Revised and enlarged translation of: L'economie de la connaissance. Massachusetts Institute of Technology Press.

Follett, B., and Paulson-Ellis, M. (2001) Review of appraisal, disciplinary and reporting arrangements for senior National Health Service (NHS) and university staff with academic and clinical duties - The report to the Secretary of State for Education and Skills Department of Education & Skills.

http://www.academicmedicine.ac.uk/uploads/folletreview.pdf

Gabbay, J., Le May, A. (2004) Evidence based guidelines of collectively constructed 'mindlines'? Ethnographic study of KM in primary care. British Medical Journal 329 (7473), 1031-1016.

Galie, N., Torbicki, A., Barst, R., Dartevelle, P., Haworth, S., Higenbottom, T., Olschewski, H., Peacock, A., Pietra, G., Rubin, L.J., Simmonneau, G., (2004) Taskforce on diagnosis and treatment of pulmonary arterial hypertension of the European Society of Cardiology, "Guidelines on diagnosis and treatment of pulmonary arterial hypertension". European Heart Journal 25, 2243-2278.

Galie, N., Torbicki, A., Barst, R., Dartevelle, P., Haworth, S., Higenbottom, T., Olschewski, H., Peacock, A., Pietra, G., Rubin, L.J., Simmonneau, G., (2009) Taskforce on diagnosis and treatment of pulmonary arterial hypertension of the European Society of Cardiology, "Guidelines on diagnosis and treatment of pulmonary arterial hypertension". European Heart Journal 30, 2493-2537.

Ghosh, J. (2003) "Medical knowledge" global public goods for health economics and public health perspectives, edited by Smith, R.D., Beaglehole, R., Woodward, D., Drager, N., chp 2, 123. Oxford University Press: Oxford.

Gibbs, S.J.R., Higenbottam, T.W. (2001) British Cardiac Society Guidelines and Medical Practice Committee, and approved by British Thoracic Society and the British Society of Rheumatology: Recommendations on management of pulmonary hypertension in clinical practice. Heart 86, (SI), 1–13.

Good, B. J. (2001) Medicine, rationality, and experience - An anthropological perspective. Cambridge University Press.

Grantham, C.E., Nichols, L.D., Schonberner, M. J. (1997) Framework for the management of intellectual capital in the healthcare industry. Health Care Finance 23(3), 1-19.

Grbich, C. (1999) Qualitative Research in Health an Introduction. Sage.

Greene, J. C. (2008) Is mixed methods social inquiry a distinctive methodology? Journal of mixed methods research. 2:7 Sage Publications. http://mmr.sagepub.com/cgi/content/abstract/2/1/7

Gunasekaran, A. (1999) "A framework for the design and audit of an activity based costing system". Managerial Auditing Journal 14(3), 118-126.

Guthrie, J., Petty, R. (1999) Management. Company Secretary 9(1), 38-41.

Guthrie, J. (2000) The Management, Measurement and Reporting of Intellectual Capital- CIMA lecture.

Habersam, M., Piber, M. (2003) Exploring Intellectual Capital in Hospitals: Two Qualitative Case Studies in Italy and Austria. European Accounting Review 12(4), 753-779.

Hamel, G., Prahalad, C. K. (1996) Competing For The Future. Harvard Business School Press: Boston.

Harvey, M.G., Lusch, R. F. (1999) Balancing the Intellectual Capital Books: Intangible Liabilities. European Management Journal 17(1), 85-92.

Health Economics Research Group (HERG), Office of Health Economics (OHE), RAND Europe (2008) Medical Research: What's it worth? Estimating the economic benefits for medical research in the UK. UK Evaluation Forum. London.

International Accounting Standards Board (IASB) (2009a) IAS 38 - Intangible Assets. London. http://www.ifrs.org/NR/rdonlyres/8A3C6720-AABE-4BE2-B776-0BBE51961AA0/0/IAS38.pdf

International Accounting Standards Board (IASB) (2009b) IFRS 3 Business combinations. London. http://www.iasplus.com/pressrel/0801buscomb2pr.pdf

International Federation of Accountants (IFAC) (1998) The Measurement and Management of Intellectual Capital. New York.

Johnson, B. R., Onwuegbuzie, A.J. (2004) Mixed Methods: A research paradigm whose time has come. Educational Research 33(7), 14-26.

Kaplan, R.S., Norton, D.P. (2004) Measuring the strategic readiness of intangible assets. Harvard Business Review, 52-63.

Koch, G., Leitner, K-H., Bornemann, M. (2000) Measuring and reporting intangible assets and results in a European Contract Research Organisation. In: Paper prepared for the Joint German-OECD Conference "Benchmarking Industry-Science Relationships". Berlin.

Leatherman, S., Sutherland, K. (2007) A Quality Chartbook Patient and Public Experience in the NHS. The Health Foundation. http://www.health.org.uk/publications/research_reports/patient_and_public.html

Leitner, K., Warden, C. (2004) Managing and reporting knowledge-based resources and processes in research organisations: specifics, lessons learned and perspectives. Management Accounting Research 15, 33-51.

Leonard, D., Sensiper, S. (2002) The role of tacit knowledge in group innovation The Strategic Management of Intellectual Capital and Organizational Knowledge edited by Choo, C.W., Bontis, N. Chp. 27, 485-495. Oxford University Press: New York.

Lev, B., Canibano, L., Marr, B. (2005) An accounting perspective on intellectual capital, Perspectives on Intellectual Capital Multidisciplinary Insights into Management, Measurement, and Reporting, edited by Marr, M. Elsevier Butterworth Heinemann: Oxford.

Lipsey, R.G., Chrystal, A. (2007) Economics. eleventh ed., Weidenfeld & Nicolson. London.

Lord, B. (1996) "Strategic management accounting: the emperor's new clothes?" Management Accounting Research 7, 346-66.

Løwendahl, B.R., Revang, Ø and Fosstenløkken, S. M. (2001) Knowledge and value creation in professional service firms: A framework for analysis. Human Relations 54(7), 911-931.

Machlup, F. (1984) Knowledge, its creation, distribution and economic significance. vol III. Princeton: Princeton University Press.

Marr, B., Gupta, O., Pike, S., Roos, G. (2003) Intellectual capital and knowledge management effectiveness. Management Decision 41(8), 771-781. http://www.emeraldsight.com/0025-1745.htm

Marr, B. (2004) Measuring and benchmarking intellectual capital. Benchmarking an International Journal 11(6), 559-570.

Marr, B. (2005) The evolution and convergence of intellectual capital as a theme, Perspectives on Intellectual capital Multidisciplinary Insights into Management, Measurement, and Reporting, edited by Marr, M. Elsevier Butterworth Heinemann: Oxford.

Mays, N., Pope, C., Popay, J. (2005) Systematically reviewing qualitative and quantitative evidence to inform management and policy making in health field. Journal of Health Service Research & Policy 10(1), 6-20.

McGillis- Hall, L. (2003) Nursing Intellectual capital: A theoretical approach for analysing nursing productivity. Nursing Economics 21(1), 14-19.

McPake, B., Kumaranayake, L., Normand, C. (2002) Health Economics An International Perspective. Routledge: London.

Mercer, C., Crow, M.R., Patton, K.W. (2002) Goodwill valuation under SFAs 142. The CPA Journal.

MERITUM (2002) Guidelines for Managing and Reporting on Intangibles. eds. Caňibano. L, Sanchez, P, Garcia-Ayuso. M, and Chaminade, C. www.eu-know.net

Mogyorosy, Z., Smith, P. (2005), The main methodological issues in costing healthcare services - A literature review, Center for Health Economics Research Paper 7. University of York.

Mouritsen, J., Thorbjǿrnsen, S., Bukh, P.N., Johnsen, M.R. (2001) Intellectual capital and the 'capable firm': narrating, visualising and numbering for managing knowledge. Accounting, Organizations and Society 26, 735-762.

Mouritsen, J., Thorbjǿrnsen, S., Bukh, P.N., Johnsen, M.R. (2004) Intellectual capital and new public management reintroducing enterprise. The Learning Organisation II (4/5), 380-392.

Mourtisen, J., Larsen, H.T. (2005) The 2nd wave of knowledge management: The management control of knowledge resources through intellectual capital information. Management Accounting Research 16, 371-394.

Mugford, H. M. (1996) How does the method of cost estimation affect the assessment of cost- effectiveness in healthcare? Doctoral thesis: Oxford University.

National Institute for Clinical Excellence (NICE) (2008) Developing costing tools, Methods guide. London.
http://www.nice.org.uk/media/F3E/57/DevelopingCostingToolsMethodsGuide.pdf

National Knowledge Service (NKS), www. nks.nhs.uk/accessed in **2005**.

Nevis, E.C, DiBella, A.J, Gould, J.M (1998) Understanding organizations as learning systems. The Strategic Management of Intellectual Capital, edited by Klein, D.A., Butterworth-Heinemann.

Newell, S., Edelman, L., Scarbrough, H., Swan, J., Bresnen, M. (2003) 'Best practice' development and transfer in the NHS: the importance of process as well as product knowledge. Health Services Management Research 16(1), 1-12.

Newell, S., Robertson, M., Scarbrough, H., Swan, J. (2009) Managing Knowledge Work and Innovation. 2nd edition Palgrave Macmillan. London.

NHS Executive (1998) Information for health: an information strategy for the modern NHS 1998-2005: A National Strategy for local Implementation. HMSO. London.

Nicolini, D., Powell, J., Conville, P., Martinez-Solano, L. (2008) Managing knowledge in the healthcare sector - A review. International Journal of Management Reviews 10 (3), 245-263.

Nonaka, I. (1994) A dynamic theory or organizational knowledge creation. Organization Science 5(1), 14-37.

Nonaka, I., Takeuchi, H. (1995) The Knowledge Creating Company, Oxford University Press: New York.

O'Regan, P., Kennedy, T., O'Donnell, D., Bontis, N., Cleary, P. (2005) Research Report: Exploring Intellectual Capital Practice in the Irish ICT Sector. The Chartered Institute of Management Accountants: London.

Organisation for Economic Cooperation and Development (OECD) (1996) Measuring what People know. OECD: Paris.

Organisation for Economic Cooperation and Development (OECD) (1998) Measuring Intangible Investment, Treatment of the components of intangible investment in the 1993 system of national accounts. Paris.

Organisation for Economic Cooperation and Development (OECD) (1999) Measuring and Reporting Intellectual Capital. Paris. http://www.oecd.org/dsti/sti/industry/indcomp/act/Ams-conf/symposium.htm

Organisation for Economic Cooperation and Development (OECD) (2006a) Creating Value from Intellectual Assets - Meeting of the OECD Council of Ministerial Level. Paris.

Organisation for Economic Cooperation and Development (OECD) (2006b) Intellectual Assets and Value Creation: Implications for Corporate Reporting. Paris. http://www.oecd.org/daf/corporate-affairs/

Papworth Foundation Hospital NHS Trust (2006) (http://www.papworthhospital.nhs.uk/docs/accounts/AnnualReport_2006.pdf)

Peng, T. A., Pike, S., Roos, G., (2007) Intellectual Capital and Performance Indicators: Taiwanese Healthcare Sector. Journal of Intellectual Capital 8(3), 538-556.

Petty, R., Guthrie. J. (2000) Intellectual Capital Literature Review: Measurement, Reporting and Management. Journal of Intellectual Capital 1(2), 156-176.

Petrash, G. (1996) Dow's journey to knowledge value management culture. European Management Journal 14(8), 365-373.

Plaice, C., Kitch, P. (2003) Health Information and Libraries Journal 20, 75-85.

Rivett, G.C. (1998, 2010) National Health Service History ***retrieved 8 July 2009 from www.nhshistory.net, update for years to 2010***

Ritchie, J. (2005) The Applications of Qualitative Research Methods: Qualitative Research Practice. A Guide for Social Science Students and Researchers, eds Ritchie, J., and Lewis, J. Sage Publications.

Roos, J., Roos, G., Edvinsson, L., Dragonetti, N.C. (1997) Intellectual Capital Navigating in the New Business Landscape. Macmillan Business.

Rouse, M .J., Daellenbach, U. S. (1999) Rethinking, research methods for resource based perspective: isolating sources of sustainable competitive advantage. Strategic Management Journal 20(5), 487-494.

Sandars, J. (2004) Practice and Policy Reviews: Knowledge management: something old, something new. Workbased Learning in Primary Care 2, 9-17.

Senge, P. (1990) The Fifth Discipline: The Art and Practice of the Learning Organization. Double Day Currency: New York.

Schneeweiss, C. (1998) "On the applicability of activity based costing as a planning tool". International Journal of Production Economics 54(3), 277-284.

Simmonds, K. (1981) "Strategic management accounting". Management Accounting 59 (4), 26-29.

Starovic, D., Marr, B. (2001) Understanding Corporate Value: managing and reporting intellectual capital, Chartered Institute of Management Accountants Technical briefing, UK.

Stefannelli, M. (2001) Clinical knowledge management to support evidence-based medicine. eds, Heller, B., Loffler, M., Musen, M., Stefanelli, M., Computer based support for clinical guidelines and protocols. Amsterdam: IOS press.

Stewart, T.A. (1997) Intellectual Capital: the New Wealth of Organizations. New York: Doubleday/ Currency.

Sullivan, P.H. (1998) "Introduction to intellectual capital management", Profiting From Intellectual Capital: Extracting Value from Innovation, edited by Sullivan, P; Wiley. New York.

Sveiby, K.E. (1997) The New Organizational Wealth: Managing and measuring knowledge based assets. Berrett-Koehler. New York.

Teece, D.J. (2000) Managing intellectual capital: organizational, strategic, and policy dimensions. Oxford University Press. Oxford.

Tsuchiya, S. A. (1994) Study of organizational knowledge- in proceedings of Management of Industrial and Corporate Knowledge ISMICK.

Tyre, M.J., von Hippel, E. (1997) The situated nature of adaptive learning in organisations. Organisation Science 8(1), 71-83.

Umemoto, K. (2002) Managing existing knowledge is not enough-knowledge management theory and practice in Japan, The Strategic Management of Intellectual Capital and Organizational Knowledge, edited by Choo, C. W., Bontis, N. Oxford University Press.

van Krogh, G., Roos, J., Slocum, K. (1994) An essay on corporate epistemology, Special Issue: Strategy: Search for New Paradigms. Strategy Management Journal 1553-71, Summer.

Wall, A. (2005) The measurement and management of intellectual capital in the public sector. Public Management Review 7:2, 289-303.

Woodward, D., Smith, R.D. (2003) Global public goods and health: concepts and issues, Global Public Goods for Health Economics and Public Health Perspectives, edited by Smith, R.D., Beaglehole, R., Woodward. D., Drager, N. Oxford University Press.

Winter, S.G. (1987) Knowledge and competence as Strategic Assets, The Competitive Challenge: Strategies of Industrial Innovation and Renewal, edited by Teece, D.J., 159-184. Cambridge MA: Ballinger.

WHO (2001) Report of the commission on macroeconomics and health – chaired by Sachs, J., Macroeconomics and Health: Investing in Health for Economic Development.

Yin, R.K. (2005) Case Study Research: Design and Methods, Sage: California.

Zack, M.H. (2002) Developing a Knowledge Strategy. The Strategic Management of Intellectual Capital and Organizational Knowledge edited by Choo, C.W. & Bontis, N. Oxford University Press.

Zigan, K., Macfarlane, F., Desombre, T. (2009) The Identification of Important Intangible Resources in Hospitals. International Journal of Public Administration 32, 1162-1181.

Appendices

Appendix 1: Study summary

University Of East Anglia

Faculty Of Health, Health Economics Group,
Chancellors Drive, Norwich
Tel (+44 (0)1284 702720
Email: s.sundram@ueaac.uk

PARTICIPANT INFORMATION SHEET

1. **Study Title: Defining and Measuring Knowledge Assets/Capital in Healthcare setting**

This is a study of what data and information is used for researching and providing Pulmonary Hypertension care. In addition to understanding what data and information is used by the Trust to monitor performance in terms of specialist health care, usage and allocation of resources. To identify which data heading / information is important to which users, the cost and benefit of this data and information to the Trust as whole.

2. **Invitation paragraph**

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

3. **Purpose of the study**

I am undertaking a study of the development and measurement of knowledge asset/ intellectual capital in an NHS specialist Hospital by way of case study of the treatment of pulmonary hypertension patients. This will form the thesis part of my Doctorate in Public Health programme.

In operational terms this will entail cataloguing the data heading and information used for research, healthcare delivery, administration, resource allocation and the links between the datasets. The importance the different users place on the different data categories will be collected.

4. **Why have I been chosen?**

You have been chosen to take part in the project, as you are part of the wide team of people in the Trust who are involved in delivery of care and research into Pulmonary Hypertension.

5. **Do I have to take part?**

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in anyway.

6. **What will happen to me if I take part?**

I will need you to answer a few questions about the kind and sources of data you use in your role in the Trust. You will be interviewed on tape about the kinds of data you use to deliver your responsibilities in the Trust. The tapes will be anonymously transcribed and then destroyed after 12 months. All information, which is collected from you during the course of deliver your responsibilities in the Trust. The tapes will be anonymously transcribed and then destroyed after 12 months. All information, which is collected from you during the course of the research, will be kept strictly confidential. Any information about you, which leaves the hospital, will have your name removed so that you cannot be recognized from it.

7. **What will happen to the results of the research study?**

It is hoped that the results will be published by end of 2006. The thesis will be available at the University of East Anglia. The results will be disseminated in the Trust through a presentation. You will not beidentified in any report/publication.

8. **Who has reviewed this study?**

Huntingdon Research Ethics Committee reviewed the study.

Contact for Further Information:
Mrs. S. Sundram
University Of East Anglia
Faculty of Health, Health Economics Group
Norwich
Tel: 01284 702720

Many thanks for giving your time and participating in the study.

University Of East Anglia

Faculty of Health,
Health Economics Group,
Chancellors Drive, Norwich NN7
Tel (+44 (0)1284 702720
Email: S.sundram@uea.ac.uk

Centre Number::
Study Number:

CONSENT FORM

Title of Project: Defining and measuring Knowledge Asset/ Capital in Healthcare setting

Name of Researcher: Sumathi Sundram

Please initial box

1. I confirm that I have read and understand the information sheet dated .... (version ....) for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any, time without giving any reason, or legal rights being affected. ☐

3. I understand the interview with me will be taped, transcribed anonymously, and the tapes will be destroyed within 12 months.

4. I agree to take part in the above study. ------------------------------------ -☐

Name of Participant		Date Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Signature	Date

1 for participant; 1 for researcher

Appendix 3: Phase I interview guide

Resource profiles and knowledge creation narratives

A. Kinds of Data: utilized and relevant to:

Service delivery, Research, Service Planning, Resource Allocation, Performance reporting

1. What kinds of data and information re Pulmonary Hypertension do you use in your job?
2. How do you capture or acquire this data?
3. Which data heading in the clinical and management database do you frequently use?
4. Do you find you have all the categories of data on patients with PH on the clinical database?
5. What information outside the databases do you need for your role in providing PH services?
6. Are there any additional data heading you will find useful?
7. Which data heading is critical in fulfilling your part in providing care for PH patients?

B. Sources of information

1. List the sources of data or information you access to get your job done.
2. Are you aware of other databases in the Trust, which have data on PH service in the Trust?
3. Do you think it will help to have common data linked between the databases?
4. If so which links would you like to see?

C. Resource Funding

1. Are there specific posts for data collection?
2. Does NHS or other fund this?
3. If other what is source of funding?

D. Others

1. Do you get requests for data on PH services?
2. If so how often do you get a request?
3. Who do you get requests from?
4. What is the most frequent data heading requested?
5. Are there any additions to your database that will make it possible for you to respond to request more easily or quickly?

Stage 1: interview: Descriptive analytical framework – (approx 6 interviews)

Primary purpose for data collection					
	Conceptual Knowledge	**Systemic Knowledge**	**Routine Knowledge**	**Routine Knowledge**	**Systemic - Conceptual Knowledge**
	Research	Service Delivery	Planning/ managing service	Resource allocation/ funding	Performance reporting
Data collected					
Sources of the data					
Method of collection e.g. face to face, returns, databases					
Purpose for collection.					
Storage Method: manual notes, mentally, database					
Dissemination method: verbally through notes, inputting in database.					
Uses made of data					
Enabling practical factors for collection and usage of data for service delivery, business, research					
Source of Funding					
Obstacles in getting/using data for purpose					
Possible changes					

Appendix 4: Phase II interview guide

Understanding obstacles and facilitators – (approx 5 interviewees)

Health Service vs. Knowledge Generation

1. In what way would you say health care delivery generates knowledge in course of service delivery?
2. How does Payment by Results impact generation of knowledge on specialist services i.e. Pulmonary Hypertension (PH)?
3. How does Foundation Trust status and the new funding environment impact on knowledge generation (research) and service delivery of PH?
4. How does commissioning of specialist services by PCTs and the funding sources impact on knowledge generation and provision of services for PH.

Dissemination of knowledge created

1. How ,
2. what ways dissemination,
3. who to
4. How wide -Are these meetings in the organisation?
5. How do you communicate results of reviews and research undertaken externally

Storage of knowledge created

1. Is the new learning recorded for the organisation?
2. How is it included in procedures notes?
3. Do procedure notes get updated and how often?
4. How is the patient information leaflet generated and communicated

Internal access to knowledge created

1. Do you attend meetings in the Trust
2. Which meetings within the Trust do you attend regularly?
3. How often are these meetings?
4. Who normally attends these meetings?

External access to knowledge created

1. Which professional meetings/networks do you participate in?
2. Which NHS groups are you a member of?
3. Have you been to any conferences nationally?
4. Have you attended any conferences internationally?

Stage 2 interview questions: Obstacles & Hindrances to different kinds of knowledge

	Experiential knowledge	Conceptual knowledge	Systematic knowledge	Routine knowledge
Impact of PbR on understanding and learning of providing services for Pulmonary Hypertension				
Impact of Foundation Trust Status on the understanding and learning of providing services for Pulmonary Hypertension				
Impact of R&D levy funding requirements impact on research and learning of providing services for Pulmonary Hypertension				
Data/knowledge source (tacit/ codified) used in their service delivery				
Processes that help increasing knowledge base for improving Pulmonary Hypertension services				
Access to the information gained by their routine activity of service delivery				
Methods for dissemination of information/knowledge gained by research/ service delivery				
How knowledge created/ gained shared and communicated				
The internally, externally networks that share knowledge created/ gained				
Meeting, Internally and externally that use knowledge created				

Appendix 5: Indicative Classification Themes- Resource Categorizations
(Source: Hospital Trusts Financial & Statutory returns)

Tangible Capital (Structural Capital)

- Review the asset register & establish the value of assets on the Trust site.
- Split the value into clinical services, specialist services and research, based on the funding source.
- Establish Trust's intellectual Properties portfolio, and its share in the academic institution portfolio.
- Establish the assets funded through NHS capital projects.
- Establish the assets funded through research sponsors both internal and external.
- Classify the fixed assets based in the Trust used by academic partners i.e. a medical College, charities.
- Review all IT equipment used in the Trust (may not appear in asset Register if below £5000). Split between research and clinical services.

Human Resources Capital

- Establish academic and research staff time and salary allocated for clinical vs. research. Method: through interviews and/ or job plans.
- Establish permanent & temporary staff time and salary allocated for clinical vs. research method: through interviews and/ or job plans.
- Establish areas of specialism e.g. based on number of patients on specialist list
- List the number of specialist training and research staff working with Trust (including those on college payroll) and the cost of these personnel.

Relational Capital (Brand value) – Reputation of NHS Research/ Organisation

- Total external funding attracted to the institution: annual value.
- Measure of reputation with partner organization, commercial, and charities: value of external funding as a proportion of total R&D funding compared to other similar organizations.

Public Goods in Health Capital

- Total charitable funding attracted to the institution: total value.

Capacity in Health Capital

- Number of specialist areas the Trust acts as national resource for all doctors and patients (% of national specialist services expenditure attributable to each trust).
- Number of specialist courses in the year to provide national education and training. The courses being weighted by no of people, qualification achieved multidisciplinary nature of course.
- Identify national protocols created (by author contribution or membership of national steering group) that originated in trust to become common practice in NHS.
- Membership/Leadership of professional academic bodies, including Cochran Collaborations etc.
- Identify the tangible reported outcomes from the completed research annually.

Appendix 6: New PH Patients Investigations at Papworth

Blood Tests

All patients

- Biochemistry: U+E, LFTs, Ca/Mg, glucose, TSH
- Haematology: FBC, ESR, INR, Lupus anticoagulant, ABO Blood Group
- Immunology: CRP, ANA, RF, SCL-70, anti-centrimere antibodies, anti-phospholipid antibodies, HIV serology if appropriate
- Cardiac markers: plasma proBNP (sent separately to West Suffolk Hospital)
- Arterial blood gas- room air unless the patient is routinely receiving LTOT

Possible thromboembolic patients:

- Request thrombophilia screen only if:
    - Family History of VTE or
    - Spontaneous acute DVT / PE or
    - Age <50

Other Investigations:

All Patients

- Chest X-ray
- 12 lead ECG
    - Consider 24hr tape if frequent palpitations
- Echocardiography
    - Request RA size, RV function and PASP
    - "Bubble Study" may be necessary if a septal defect is suspected
- Lung function
    - Six minute walk test
    - Spirometry, static lung volumes and TLCO
- Overnight oximetry if:
    - Symptoms suggest possible sleep apnoea
    - Borderline oxygenation on ABG (pO_2 8-10kPa at rest) or on

exercise (desaturation <90%)

- CT Pulmonary angiogram
    - State indication clearly and discuss with on call radiologist
    - Ensure that the patient has no contra-indication to IV contrast
    - Inform radiology of any significant renal impairment (creat >150), diabetes or Metformin use (usually with-held before and after contrast)
- Right Heart Catheter
    - Ensure INR and Hb are recorded in the notes
- Pulmonary Angiogram
    - Performed at the time of catheter study in order to clarify operability
    - Ensure that the patient has no contra-indication to IV contrast

CTEPH Phase 2**: (usually separate admission**)

- MR Pulmonary Angiography
- IVC Filter insertion
- Age greater than 40yr or family history of premature atherosclerotic disease:
    - Carotid Doppler Studies
    - Coronary Angiogram

Source: Papworth Hospitals NHS Foundation Trust-PVDU unit guidelines for junior medical staff (Jul 2005)

Appendix 7: Pulmonary hypertension (PH) specialised services in the NHS

European Society of Cardiology guidelines define it:

> "*As a group of diseases associated with thickening of the arterial walls in the lungs leading to reduced flow of blood in the lungs, putting a strain on the right side of the heart leading to its failure and premature death.*"

Some patients present for treatment exhibiting features of heart failure caused by left heart dysfunction (Gibbs and Higenbottam, 2001; Galie et al., 2004, 2009). Gibbs and Higenbottam (2001) found that standard therapies for heart failure such as ACE inhibitors and B-blockers were shown not only to be ineffective but detrimental to these patients thus requiring alternative therapeutic options (Gibbs and Higenbottam, 2001).

Understanding of the mechanism of the disease, diagnostic processes and treatment have advanced in the past decade including the identification of a variety of genetic mutations in familial pulmonary hypertension. The advances have helped establish the clinical classification of the disease based on pathophysiological mechanisms, clinical presentation and therapeutic options. The interactions between mechanisms that initiate and progress the pathological changes that result in PH are still not well understood so further research and treatments are being developed.

The diagnostic strategy currently used for the disease consists of a series of investigations to confirm a diagnosis and clarify the clinical class of disease based on its severity (Galie, et al., 2004, 2009). Following diagnosis of the condition, the severity of the condition is evaluated through assessing exercise capacity and further haemodynamic tests. The stages of treatment are suspicion of the condition, detection of PH, clinical class identification and evaluation of the level of functional capacity and haemodynamics (Galie et al., 2004, 2009).

The British Cardiac Society recommendations (Gibbs and Higenbottam, 2001) on the clinical management of PH, approved by the British Thoracic Society and the British Society of Rheumatology, suggest that the PH clinical team at each centre specialising in this disease needs to include specialist respiratory physicians, specialist PH nurses, radiologists, cardiac and lung function technicians, ward staff and management support.

The clinical protocol (Gibbs and Higenbottam, 2001; DH, 2003a, 2007a) recommends the following steps for investigation and treatment of PH. Referrals of patients for diagnosis and treatment are to be made to the named specialist in PH. The patient may be seen in outpatients or transferred from another hospital for further tests that may include lung imaging and cardiac catheterisation. The decision to perform investigations as inpatient or outpatient procedure depends on the clinical state of the patient and their proximity to a centre, with admission of patients co-ordinated by the consultant physician. The PH nurse and related junior medical staff are required to ensure that on call pulmonary hypertension staff are aware of the patient's admission.

On completion of investigations a plan for the management of the patient is to be discussed and presented to the patient. Where patients require drug therapy, appropriate arrangements to commence the therapy are to be made. Referral to a surgeon is required for patients needing surgical procedures, such as Pulmonary Thromboendarterectomy (PTE), lung transplantation or atrial septostomy. The protocol suggests PH patients should be followed up for life or until surgery with regular review of their therapy. In the NHS, the nationally agreed clinical schedule for follow ups of PH patients in the first year is at six weeks, three months, six months and nine months following assessment. After the first year the follow-ups at specialist centres are at half yearly intervals and sooner if the clinical condition requires more frequent follow-up (DH, 2003a, 2007a).

The clinical protocol (Gibbs and Higenbottam, 2001; DH, 2003a, 2007a) recommends that a transthoracic echocardiogram be used to screen patients where PH is suspected. Referral of patients to a designated specialist centre is normally made after an ECG, chest X-ray, simple spirometry and demonstration of PH by echocardiography, but usually before cardiac catheterisation. The risk of early death from this condition requires that referrals to specialist physicians are not delayed.

The clinical guidelines highlight that as the symptoms of PH are relatively non-specific, breathlessness being the most common symptom, diagnosis is confirmed through a right heart catheterisation (Gibbs and Higenbottam, 2001). The aetiology or original cause of PH needs to be established to determine optimal treatment for patients. Acute vasodilator testing is recommended at the time of cardiac catheterisation as the response to acute vasodilator testing by patients helps identify those who may respond to the therapeutic option of long-term oral vasodilator treatment.

The severity of the PH is classified using the New York Heart association functional classification drawn up by the World Health Organisation 1998 (Gibbs and Higenbottam, 2001; Galie et al., 2004, 2009). These classifications are as follows:

Class I - Patients with pulmonary hypertension but no limitation of physical activity.

Class II - Patients with pulmonary hypertension resulting in limitation on moderate to heavy physical activity.

Class IIIA - Patients with pulmonary hypertension resulting in limitation on mild physical activity (e.g. walking up a flight of stairs, carrying objects)

Class IIIB - Patients with pulmonary hypertension resulting in limitation on minimal physical activity (e.g. dressing, bathing, walking around their house)

Class IV - Patients with pulmonary hypertension with breathlessness at rest who are unable to carry out any physical activity without symptoms. These patients manifest signs of right heart failure.

Some pharmaceutical drugs that are suitable for managing this condition are available and continue to be developed. The early pharmaceutical therapeutic options are diuretics, anticoagulation, oxygen, rate control +/- intravenous prostacyclin therapy. Newer pharmaceutical therapeutic options attempt to target by disease type, severity and patient competence (Galie et al., 2004, 2009). Patients with PH, however, require lifelong monitoring in a specialist centre with the instigation of appropriate therapies as the disease evolves (DH, 2003a).

Certain PH patients, those that have chronic thromboembolic pulmonary hypertension (CTEPH), may be suitable for the surgical intervention pulmonary thromboendarterectomy (PTE). The other surgical option available to other categories of PH patients are lung or heart and lung transplant, an option limited by availability of donor organs (Gibbs and Higenbottam, 2001).

Summarising, PH is a rapidly progressive condition which obliterates the blood vessels resulting in increased pressure in the blood vessels on the right side of the heart causing failure of the heart. Some patients can present with features of left heart failure however standard therapies for this condition, such as ACE inhibitors and B-blockers if administered to PH patients can be detrimental (Gibbs and Higenbottam, 2001; Galie et al., 2004, 2009).

Appendix 8: PH Patients Pathway at Papworth Hospital

The pathway of a patient referred to Papworth hospital for a diagnosis of PH is as follows. A patient is usually referred to Papworth hospital by the consultant surgeon or physician from a secondary care hospital, sometimes to the cardiac services. The cardiac team at Papworth hospital refer the patient forward to the PH team. This happens because the symptoms for this condition can be similar to that of a cardiac condition (Chapter 5, 5.4). Referrals are made by the secondary care clinician usually when the patient is stable but diagnosis of PH is not clear from the symptoms experienced by the patient. Some necessary tests, such as ECGs, blood tests or X-rays may have been undertaken at the secondary hospital. On referral, patients are admitted to the ward for investigations to confirm diagnosis and to assess the severity of the condition. In instances where the patient is likely to be suitable for surgical intervention two separate admissions for investigations are made. The first admission is for investigations to assess the severity of the condition and the second is for assessing the risk to surgery. In cases of new patients who are very ill they are transferred from other hospitals as urgent inpatients.

In the case of stable patients the specialist clinicians at the specialist centre first review the patient's notes and the test results that have been forwarded by the referring hospital. Investigations, such as blood tests, ECGs, lung function and X-ray, are repeated and further tests, such as overnight oximetry, CT pulmonary angiogram, right heart catheter and pulmonary angiogram, are undertaken for assessment of the patient's condition in order to confirm or rule out, a diagnosis of PH. Additionally, some of these tests help establish the severity of the condition. Admissions of patients to the hospital are mainly pre-planned and the investigations are therefore scheduled in advance. The admission of new patients to the hospital is planned for the beginning of the week so as to be able to discharge them before the weekend if possible. The patients treated at Papworth hospital can travel from anywhere in the UK.

A patient referred to Papworth hospital for diagnosis and treatment of PH is usually seen as an inpatient staying for 3-7 days per episode. In some instances, where the patient is relatively well and lives near the hospital, they may request to come into hospital over a series of days rather than as an inpatient. In such instances patients are admitted on the thoracic day ward while the various tests are undertaken. The assessment of a patient at Papworth hospital may be as an inpatient activity or day ward activity based on the clinical status of the patient and if they live in close proximity to the hospital. Similarly, based on the clinical status of the patient, the geography and timescale of the follow-up of the patient is undertaken in the outpatient clinic, on the thoracic day ward or as an inpatient.

On admission, investigations are undertaken as per the guidelines to assess exercise capacity, heamodynamics and the primary cause of PH (Gibbs and Higenbottam, 2001; Galie et al., 2004, 2009). These investigations help confirm diagnosis and establish the levels of severity of the condition. Such investigations are planned prior to the patient arriving at the hospital, based on information available from the referral letter of the secondary care clinician. The patient is admitted based on an assessment of the severity of their illness based on the available information. Clinical aspects of admission to the day ward or as an inpatient are undertaken by the junior clinician after collecting and confirming both clinical and administrative details about the patient.

On receipt of a referral letter, Papworth hospital contacts the patient with a date and time for the first appointment to see the specialist physicians. The first appointment is normally as an inpatient in the thoracic ward or in the day ward if clinical status and proximity to the hospital permit. The patient arriving at the specialist centre reception meets the team secretary who takes them through to the ward and introduces the patient to his or her allocated nurse. If copies of the notes from the referring secondary care hospital are not received, the team secretary follows up with the secondary hospital to attempt to get copies in time for the patient's visit to the hospital. The team secretary or allocated nurse takes details of the patient including name, address, date of birth, name of GP etc as part of admitting them into the hospital. The team secretary then enters the patient details into the hospital "patient activity system" (PAS) and sets up the clinical notes file for that patient in the hospital systems.

The allocated nurse establishes through the details taken from the patient that the person being admitted is the one referred for diagnosis and checks that copies of the notes from the secondary hospital have been received. The nurse then shows the patient and family to the bed and does the preliminary admitting by taking a short history, notes all medication currently being taken, noting any allergies, blood pressure and temperature. The current weight of the patient is taken for any weight based dosage of medication that needs to be administered. The nurse also takes charge of any current medication the patient has been asked to bring to the hospital. Such medication is labelled and stored in a locked medicine cupboard on the ward. The mode of transport used by the patient to get to hospital and the distance travelled is also noted. This data is used to establish if hospital transport will need to be organised for the patient on discharge and for follow-up visits. The name of next of kin and their telephone number is noted so that in the case of an emergency the hospital is in a position to contact the relevant person. Any specific wishes of patients in relation to their care, for example religious requirements, blood transfusions, resuscitation wishes and so on, are sought and recorded in the notes. The nurse prepares a nursing care plan for the patient stay based on details available from the referral letter and previous test results, highlighting patient wishes where pertinent. When the patient is settled in the ward the nurse shows the patient how to complete the breakfast, lunch and dinner order forms. The allocated nurse explains the layout of the ward in terms of facilities, nurses' station, etc and informs the patients of the names of the doctors and specialist nurses who are to be involved in their care.

The junior doctor then sees the patient on the ward to "clerk" the patient. The process involves taking a history of the present condition by asking about the kind of symptoms e.g. breathlessness, chest pain, swelling in legs etc, they have been experiencing on a regular basis. The patient's medical history, personal history and family medical history are noted on the patient's notes. Any treatment the patient may be undergoing is noted in the clinical notes becoming accessible for service delivery and research or knowledge creation.

The patient's experience of the progression of their symptoms and the period over which such symptoms were experienced are gathered in the process of admission. The patient's "co-morbidity", that is other illnesses, and/or any other underlying "risk factors" like connective tissue diseases, HIV etc, which may be the cause of pulmonary hypertension, are explored. Usually a complete clinical examination of the patient is undertaken to corroborate and confirm the patient's view of their symptoms with their clinical history. A provisional diagnosis and the cause of PH is made. Any further investigations, for example lung imaging or pulmonary angiography that are necessary, are organised by the staff. The admitted patient's notes are then presented at the multidisciplinary team meeting. Here the details of the patient's condition are reviewed and diagnosis or further tests that may be required are agreed. The relevant treatment plan is drawn up and the nursing care plan updated. Following on from these processes, the senior specialist physician meets the patient on the ward and if necessary examines the patient again.

The senior specialist physician then communicates the diagnosis and discusses the treatment plan with the patient and family, if agreed with patient, during the ward round of the day. The senior physician answers any questions the patient or family have about the condition, the treatment options available, etc. The pros and cons of the treatment plan are explained by the senior physician and any adjustments are made, taking into account the patient's specific needs. The ward rounds occur every weekday in the mornings and are attended by the nurse, the junior doctors and the specialist registrar or research registrar who monitor the progress of the patient.

On the ward round, discussions with the senior physician help the clinical team to understand the patient's experience and make judgements on how much the patient and family understand about the disease and the services being provided. The specialist nursing staff start to educate the patients and family on living with the condition. Details of the treatment the patient will receive at the hospital are explained to the patient and, where agreed, the family. Furthermore, support and education is provided to the patient on how they and their family can manage the condition once back at home. The education process helps clear up any misconceptions the patient and family may have of the severity of their illness or the treatments that are available to them. In addition, there is advice provided at the hospital on social support available to the patient from the social worker in the hospital. As the treatment is emerging for this condition, in the words of a consultant PH physician, the patients are seen as an "*important source of knowledge*". The staff actively collect and reflect on the patients' experience of the condition and of managing their illness as part of knowledge creation and development of pulmonary hypertension services. Additionally, the patients and family are encouraged to be involved in their care and share experiences with other PH patients. Such sharing by patients creates additional processes and resources for the development of knowledge about the condition and development of health services for the condition.