1

The healthcare information domain

Introduction

This chapter deals with the nature of healthcare itself – one of the largest, oldest and most important of the information domains – and of its associated disciplines and professions. The analysis is necessary in order to set the context for later discussion of information users, resources, etc., and involves several domain analysis approaches, particularly:

- consideration of the kind of documents encountered in the discipline
- epistemological consideration of the nature of healthcare knowledge
- structures and organizations that are important for healthcare and its knowledge base
- bibliometrics, to illustrate the size and nature of the healthcare knowledge base.

Each of these has a historical perspective, which will be considered in Chapter 2.

Because a discipline is defined in large measure by its knowledge base, generally expressed as information in documents, this chapter focuses on the 'creation' stage of the information chain. The topics discussed here have extensive literatures in themselves, so this treatment will be tightly focused and very selective in its quotation of references and resources, which will usually be used simply as examples.

Nature of the discipline

In order to understand the healthcare domain in information terms, it is necessary first to understand something of the disciplines and professions within it. Before that, the idea of 'healthcare', and indeed of 'health' itself, must be clarified.

Health and healthcare

According to the World Health Organization (WHO), ***health*** is 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. This definition was established in the WHO constitution, written in 1946, and has not been modified since (World Health Organization, 1946).

This ambitious definition is a broad one, unusually so for the time when it was originated, insisting that health includes social, as well as mental and physical well-being, and also in promoting a positive 'well-being' view of health. This is in contrast to a more negative viewpoint, which has influenced much medical practice: that health is simply the absence of disease (a diagnosed biological malfunction) or illness (the personal experience of the consequences of disease). These two views of health persist side by side (Baggott, 2004).

Healthcare has a similar dual aspect. The Oxford English Dictionary defines it very broadly as 'care for the general health of a person, community etc., especially that provided by an organized health service'. Another broad definition, seemingly following from the WHO concept but emphasizing that healthcare is the business of professionals, is offered, without attribution, by Wikipedia and several other websites: 'the prevention, treatment and management of illness and the preservation of mental and physical well-being through the services offered by the medical, nursing and allied health professions'. Merriam Webster's Medical Dictionary, by contrast, uses the narrower concept: 'the maintaining and restoration of health by the treatment and prevention of disease especially by trained and licensed professionals (as in medicine, dentistry, clinical psychology, and public health)'.

Taken together, the organized provision of professional services for maintaining and restoring health constitutes a ***healthcare system***. Such systems are structured in various ways in different countries. In the United Kingdom (UK), services are divided into prevention, primary care, secondary care and tertiary care (Baggott, 2004; Talbot-Smith and Pollock, 2006). Preventive services include screening and immunization, as well as activities

sometimes characterized as health promotion, such as campaigns against cigarette smoking, or in favour of exercise. Primary care encompasses community services (including prevention and promotion) involving general practitioners (family doctors), district nurses, health visitors and a variety of other paramedical and social care services. Secondary care includes more specialist services, usually provided in hospitals, including in-patient and out-patient treatment and laboratory testing. Tertiary care involves highly specialized care for less common problems, usually provided in larger hospitals. There are also services, such as public health and various support functions, which cut across these 'tiers of care'.

Services are organized differently in other countries, with less emphasis in some cases, for example, on the primary care offered by the generalist family doctor. In any situation, the structure is likely to alter over time as, for example, procedures which once required admission to hospital are carried out in a local clinic. Nonetheless, this outline gives an idea of the complexity of healthcare systems, and the variety of professions involved.

Healthcare professions

A more detailed idea of the variety of professions involved in healthcare provision may be gained by considering the taxonomy of careers in the National Health Service (NHS) in England, provided on its website in late 2009 (www.nhscareers.nhs.uk). These are categorized alphabetically in ten main sections, with two levels of subdivision. For clarity, and to keep the long list within bounds, the top levels are shown below, with part or all of the second and third levels where this provides clarity and/or example.

Allied health professionals

Arts therapy
- Art therapy
- Drama therapy
- Music therapy

Chiropody and podiatry [foot problems]
Dietetics
Operating department practice
Orthoptics [eye problems]
Occupational therapy

- Physiotherapy
- Prosthetics and orthotics
- Psychology
  - Clinical psychology
  - Health psychology
  - Counselling psychology
  - Forensic psychology
- Psychotherapy
- Radiography
  - Diagnostic radiography
  - Therapeutic radiography
  - etc.
- Speech and language therapy
- Ambulance
  - Ambulance technician
  - Call handler
  - Paramedic
  - etc.
- Dental
  - Dentists
  - Dental nurses
  - Dental hygienists
  - Dental therapists
  - Dental technicians
- Doctors
  - Medical specialities
    - Cardiology
    - Dermatology
    - Occupational medicine
    - Pharmaceutical medicine
    - etc.
  - Surgical specialities
    - Cardiothoracic surgery
    - Ear, nose and throat surgery
    - Plastic surgery
    - etc.
  - Psychiatry
    - Forensic psychiatry
    - Learning disability
    - etc.

- General practice
- Paediatrics and child health
  - Obstetrics and gynaecology
- Pathology
  - Chemical pathology
  - Haematology
  - Histopathology
  - Immunology
  - etc.
- Radiology
- Anaesthetics
- Ophthalmology

Healthcare science

- Pharmacy
  - Hospital pharmacy
  - Community pharmacy
  - etc.
- Life Sciences
  - Clinical embryology
  - Phlebotomy
  - Clinical biochemistry
  - Clinical microbiology
  - etc.
- Physiological sciences
  - Audiology
  - Cardiography
  - Gastroenterology
  - Respiratory physiology
  - etc.
- Clinical engineering and physical sciences
  - Clinical engineering
  - Medical physics
  - Medical illustration

Health informatics

- Information and communication technology
- Knowledge management
- Information management
- Clinical informatics

Management

- General management

- Practice management
- Financial management
- Clinical management
- etc.

Midwifery

Nursing

- Adult nursing
- Mental health nursing
- School nursing
- etc.

Wider healthcare team

- Administration
  - Medical records
  - etc.
- Estates (property maintenance)
- Corporate services
  - Architecture
  - Surveying
  - Human resources
  - etc.
- Clinical support services
  - Social work
  - Counselling
  - Complementary and alternative medicine
  - etc.
- Domestic services
  - Catering
  - Housekeeping
  - etc.
- Support services
  - Driving
  - Storekeeping
  - etc.

This emphasizes the complexity of health service provision and the very varied roles required. At the risk of over-simplification, these can be represented as two groups:

Healthcare professions and roles

Doctors, nursing, midwifery, dentists, allied healthcare professions, healthcare science, ambulance.

Ancillary functions and roles

Health informatics, management, wider healthcare team.

The first group comprises those activities which are essentially healthcare related. The second comprises more general activities (information technology (IT) management, librarianship, financial management, counselling, etc.) which happen to be carried out in a healthcare setting. However, some functions which appear here as ancillary are in fact healthcare specific: complementary and alternative medicine, clinical management and clinical informatics, for example. Conversely, an ambulance-call handler might be said to be practising a general role in a healthcare context. Nonetheless, in a general sense two distinct groupings within healthcare services can be seen, both of which will be producers and users of information.

The disciplinary background

The analysis above covers professions and roles in the practice of healthcare provision. In considering the nature of healthcare, however, its basis in more fundamental disciplines must be considered.

It is self-evident that the work of doctors, nurses and the other healthcare professions is based upon an understanding of the biomedical sciences, and the education and training of all healthcare professionals includes such sciences. Indeed, the practical expression of these sciences can be seen above, in pathology, clinical biochemistry and microbiology, and so on. Again, from the above, the application of chemistry, physics and engineering can be seen.

If the 'negative' understanding of health – an absence of disease – is taken, then healthcare will be a matter of preventing, diagnosing and treating disease. This is a rather traditional model of healthcare, with doctors and the profession of medicine taking the main role, supported by other healthcare professions. Healthcare in this sense is firmly based on biomedical sciences, the 'basic sciences' which traditionally made up the first years of medical education. There is no definitive understanding of exactly which sciences these are. Recent explanations include:

- 'such as anatomy, pharmacology and pathology' [British Medical Association] (British Medical Association, 2005)

- 'basic sciences – anatomy, biochemistry and physiology' [European medical school survey] (Jippes and Majoor, 2008)
- 'traditional disciplines of anatomy, biochemistry, microbiology, pharmacology and physiology' [USA medical school survey] (Mallon, Biebuyck and Jones, 2003)
- 'basic sciences [of] neuroscience, gross anatomy, cell biology, physiology, biochemistry, behavioural and social science, embryology, pharmacology, genetics, and neurology' [United States (US) medical school curriculum] (Clough, Shea, Hamilton, Estavillo, Rupp, Browning and Lal, 2004)
- anatomy, physiology, pathology, immunology, microbiology [Canadian nursing curriculum] (Thompson Rivers University, 2009)
- anatomy, physiology, microbiology, lifespan development, chemistry [US nursing curriculum] (University of North Carolina Greensboro, 2009)
- chemistry, biology, physics, microbiology, anatomy, physiology, pharmacology, toxicology [US pharmacy curriculum] (Purdue University, 2009)
- anatomy, biology, chemistry, mathematics, statistics, physics [US radiology curriculum] (Ohio State University, 2009)
- anatomy, biochemistry, cell biology, genetics, immunology, microbiology, molecular biology, nutrition, pathology, pharmacology and physiology (General Medical Council, 2009)

A recent trend, in line with general educational practice, has been to specify this background knowledge in terms of competencies, rather than of disciplines and courses. An example of this is a report on scientific foundations for future physicians from the US Howard Hughes Medical Institute and Association of American Medical Colleges (AAMC-HHMI 2009). This expresses the scientific knowledge needed by doctors in terms of general scientific competencies, illustrated by medical examples. For instance, a doctor should be able to:

- Explain how the regulation of major biochemical energy production pathways and the synthesis/degration of macromolecules function to maintain health and identify major forms of dysregulation in disease.
- Explain how lack of insulin results in the metabolic consequences of diabetes mellitus, such as hyperglycemia and ketoacidosis.
- Explain how urea metabolism and its abnormal regulation in renal and hepatic disease can result in uremia.

Although this competencies-based specification may be more helpful in promoting understanding of what doctors should know, and why, it does not

alter the general perspective of the breadth of sciences relevant to healthcare.

It is clear that, although expressed differently and with varying emphasis in different environments, the whole spectrum of biomedical science, and much of other sciences, is seen to be of relevance as the underlying basis for healthcare education. As healthcare education and training have changed, there has been a trend towards merging these subjects more closely with clinical training (see, for example, Clough, Shea, Hamilton, Estavillo, Rupp, Browning and Lal, 2004; Jippes and Majoor, 2008), with consequent concerns that there may be a damaging loss of foundational knowledge (see, for example, British Medical Association, 2005). There have been similar concerns about an emphasis on interpersonal issues in nurse training, at the expense of scientific knowledge (Sturgeon, 2008). Furthermore, changes in the way biomedical science itself is carried out, with consequent restructuring and renaming of departments and institutions, affects the issue (see, for example, Mallon, Biebuyck and Jones, 2003 for a survey of basic science departments in American medical schools).

Behavioural and social sciences were mentioned in one of the examples of basic sciences above. As the broader and more holistic understanding of health – well-being, including the social context – comes to the fore, so the healthcare system will necessarily rely on a greater range of 'non-scientific' disciplines. The British Medical Association (2005), for example, recommends that undergraduate medical education should include 'important social issues, such as homelessness and care of the elderly [and] … factors influencing health and healthcare . . . including political, socioeconomic, cultural and religious factors'. De Gooijer (2002) similarly suggests that healthcare in Western Europe is 'constantly implementing new combinations of science, technology, organization, economics, politics, philosophy, opinions and fashion', and that consequently healthcare systems are complex, and difficult to compare across countries.

Taking these arguments even further, the relatively new discipline of 'health studies' uses the broadest feasible definition of health and its promotion, as a matter of the realization of human potential in all ways. The disciplines contributing to health studies include biomedicine, medical sciences and epidemiology – although these are by no means the central concepts – and also psychology, social policy, economics, organization and management, cultural studies, history, philosophy, sociology and education (Duncan, 2007). This interdisciplinary and multidisciplinary nature is emphasized by the UK's Quality Assurance Agency for Higher Education, which notes that health studies courses may rely upon 'the physical and social sciences and the humanities' (Quality Assurance Agency 2002).

The situation therefore seems to be one in which virtually any academic discipline may be seen as important in supporting the healthcare professions and healthcare systems. To help clarify matters, it is necessary to ask what sort of a discipline healthcare is – if indeed it is a discipline at all.

What kind of discipline?

The educational philosopher Paul Hirst argues that, since disciplines are closely associated with their knowledge base, we can understand a discipline by understanding its 'form of knowledge' (Hirst, 1974; Hirst and Peters, 1970; Walsh, 1993). Hirst identifies seven main domains or forms of knowledge, defined by the fundamental nature of the knowledge and concepts with which they deal: mathematics, physical sciences, human sciences, literature and the fine arts, morality, religion, and philosophy. Where a discipline equates to one of these forms, it is what would be regarded as a 'pure' academic subject. Hirst also recognizes 'practical disciplines', based on one of these forms, but oriented toward solving practical problems. Engineering, for example, would be a practical discipline based on the form of the physical sciences.

Many academic subjects, however, do not align neatly with any of the forms defined by Hirst. Rather, they are focused on a topic or subject of interest, using any of the forms which are useful in studying and understanding it. Hirst refers to these as 'fields of study'; they are typically, though not necessarily, multidisciplinary; he gives the example of women's studies. More recently, Bawden (2007) and Robinson (2009) have argued that the library and information sciences may be regarded as a field of study focused on information. It seems clear that adopting the broader meanings of healthcare, as outlined above, suggests that it is best understood as a field of study focusing on the broad concept of health and supporting a number of practical healthcare disciplines. If this view is taken, then there will be no expectation of any particular form of knowledge associated with the topic, and it will draw as required from the biological and social sciences, and beyond them to the physical sciences and humanities.

However, it is true to say that much of what is generally understood as healthcare takes the more restrictive view of health, and is viewed as the prevention, diagnosis and treatment of disease. In this concept healthcare is firmly based around medicine, itself relying almost entirely on biomedical sciences, though the model was criticized decades ago for ignoring the social and behavioural dimensions of illness (Engel, 1977). In Hirst's terms,

medicine and related professions are generally thought of as practical disciplines based on the form of knowledge of the biological sciences. This 'embedding' of a scientifically based discipline into a broader field of study, with diverse forms of knowledge at its base, is the root cause of the complexity and differing views noted above. As will be seen later, this has very real and practical consequences for the kinds of healthcare knowledge that are created in the discipline's information chain.

An immediate example can be seen in the Medical Subject Headings (MeSH) vocabulary, widely used for indexing of healthcare subject matter. Of the 16 main headings in MeSH, 5 are mainly related to narrowly defined healthcare concepts (diseases; chemicals and drugs; analytical, diagnostic and therapeutic techniques and equipment; psychiatry and psychology; and healthcare), 4 to basic sciences (anatomy; organisms; biological sciences; and natural sciences), and 4 to wider disciplines [anthropology, education, sociology and social phenomena; technology, industry and agriculture; humanities; and information science]. (The remaining 3 deal with people, places and publications, rather than with subjects.) Even in this rather traditionally medically oriented vocabulary, the need to include other disciplines is evident.

These ideas may be used to consider the nature of healthcare knowledge, and its creation, in more detail.

Nature of healthcare knowledge

In this section we will consider in general terms what healthcare knowledge is like. We will first look at the kinds or forms of knowledge involved, and then in more detail at the nature of some of those forms. We will then consider how much healthcare knowledge there is, how that quantity is changing, and the kinds of documents which communicate it.

Forms of knowledge

It will be obvious from what has been said above that there is no such single entity as 'healthcare knowledge'; the topic is much too diverse for that. Furthermore, the nature of medical knowledge itself changes greatly over time. One of the main themes is that of the balance between the general and the particular, the focus on an abstract 'universal' or a general disease type, as against the focus on the specific and unique case being treated (see, for

example, Nutton, 2004 on these issues in classical medicine, and Wear, 1995 on the conflict between these forms of medical knowledge in the Renaissance). The balance between, on the one hand, theory and philosophy expounded in the 'canon' of approved medical texts, and on the other the empirical evidence provided by examination of a patient, has not always taken the form it does today. And it is also the case that some forms of knowledge simply 'leave' the domain; who now has any insight into medical astrology, a major tool of the physician in medieval times and afterwards? (Nutton, 1995). We see the issue of 'what counts' as healthcare knowledge arising today in the contested status of some alternative forms of therapy. We should therefore be careful to acknowledge that the nature of healthcare knowledge – even in those aspects of it which are generally accepted today – has changed from the past, and may change again in the future.

Most obviously, the knowledge needed by the practitioner or provider of healthcare will differ from that needed by recipients, patients and carers. However, health information for lay people has been provided for hundreds of years, and this trend has been reinforced by late 20th century developments in consumer health information and the concept of the 'expert patient', so that this distinction is not so black and white as might be thought.

The idea of the 'practice knowledge' of the healthcare professional has received much attention since 1990 (see Higgs, Richardson and Dahlgren, 2004 for an overview). This has led to several typologies or categorizations of healthcare knowledge, in general terms. It has also led to a recognition that practitioners will often need to use, integrate and criticize different forms of knowledge, and not rely on a single form, whether this be an undue reliance only on data from rigorous clinical research or, at the other extreme, a sole reliance on personal professional experience. The ability to combine forms of knowledge appropriately has been termed 'practice wisdom' (Richardson, Higgs and Dahlgren, 2004); assisting practitioners to do this should be one of the aims of healthcare information specialists.

A common view in Western philosophy is that there are two main ways of 'knowing': propositional knowledge ('knowing that') and non-propositional, or tacit knowledge ('knowing how'). Propositional knowledge comes from rational enquiry and research, especially in the sciences. It has traditionally been given a higher status than tacit knowledge, which is gained by professional or life experience. In healthcare, as in other areas which have a scientific basis and also a practice 'craft' element, there is a tension between the views of what the knowledge base of such disciplines should be like (Higgs and Titchen, 2000; Higgs, Andresen and Fish, 2004). Some contend that it should, as far as possible, be objective and generalizable propositional

knowledge, obtained from research and theory. Such a view underlies evidence-based medicine, with its reliance on published scientific and clinical research. An alternative view argues for the inclusion, or even the primacy, of subjective, interpretive and context-specific knowledge, largely derived from reflection on and interpretation of personal and professional experience. This attitude points to some limitations of reliance on evidence-based practice in offering the best care in a specific situation, and offers practitioners the freedom to use different forms of knowledge to achieve healthcare aims. Most commentators now agree on the need to integrate different forms of knowledge for best healthcare practice, including in particular the need to relate personal experience to the objective evidence of the literature (Higgs, Fish and Rothwell, 2004; Higgs, Jones, Edwards and Beeston, 2004; Richardson, Dahlgren and Higgs, 2004; see also Bawden, 2002 for an analysis of healthcare knowledge in terms of Karl Popper's somewhat similar epistemology).

A simple typology of healthcare knowledge, now generally accepted, divides non-propositional knowledge into two types: professional craft knowledge, derived from experience in practice, and personal knowledge, derived from personal life experience. This gives a threefold breakdown of healthcare knowledge (Higgs and Titchen, 2000):

- Propositional knowledge: publicly available, communicable, objective knowledge, of the kind typically generated by research, theory, observation and experiment. It is 'scientific' and 'technical' knowledge, using these terms in a general way. Most of the knowledge base of medicine and other science-based healthcare disciplines, and of the underlying sciences, is of this form.
- Practical craft knowledge: the kind of tacit knowledge gained by professional experience, which is difficult to communicate in an abstract general way. It is associated with the ideas of 'professional judgement', 'clinical intuition', etc. It is not incompatible with the use of formal propositional knowledge, and an expert practitioner is able to integrate the two.
- Personal knowledge: subjective knowledge, which individuals gain by reflecting on their experiences, not necessarily just in a professional context, and which is associated with attitudes and values and hence influences professional judgement. In a healthcare context, this is the kind of knowledge which allows a practitioner 'to appreciate the concerns, needs and frames of reference of their patients or clients, to learn to cope with pain, frailty and human endeavour, and to learn to

deal with ethical dilemmas within the clinical situation' (Higgs and Titchen, 2000, 29). It may also include cultural knowledge, important in the provision of healthcare in a multicultural setting (Henley and Twible, 2000).

Traditionally, propositional 'scientific' knowledge has always been given priority in healthcare generally, and in medicine specifically. Greater attention is now being given to the value of practical and personal knowledge as an essential complement for effective healthcare practice (see Figure 1.1). Objective, scientifically based knowledge still dominates the practice of

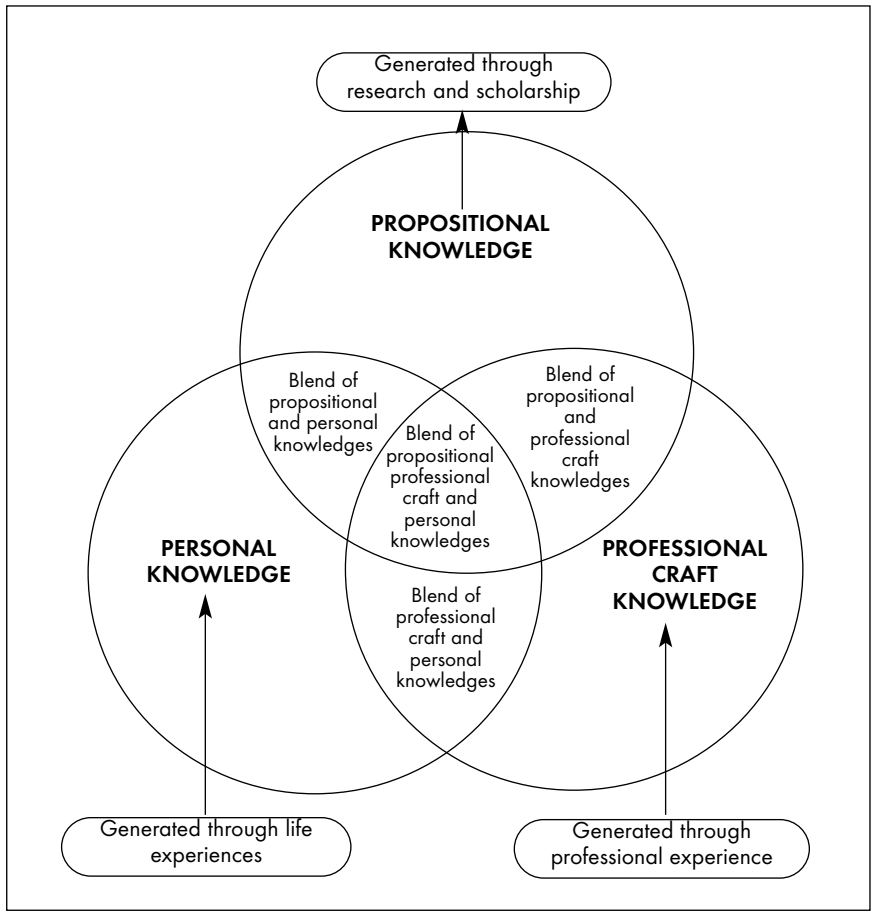

Figure 1.1 Forms and derivation of knowledge
Reproduced with permission from Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 2004

disciplines such as medicine and physiotherapy – albeit that such knowledge is not static, but potentially rapidly changing, requiring changes in practice – while more subjective and context-specific tacit practice knowledge is currently more accepted in disciplines such as nursing and occupational therapy (Higgs, Andreson and Fish, 2004; Fleming and Mattingly, 2000).

For effective practice, the three forms of knowledge should be used together. Titchen, McGinley and McCormack (2004) give a specific and detailed example of this, based on the work of a nurse caring for a particular patient, and combining technical knowledge, practical know-how and personal knowledge.

Healthcare knowledge viewed in this way is complicated and without very clear boundaries, and requires integration of sources beyond those of 'traditional' science and medicine. 'A broader notion of health professional knowledge is required that is derived from diverse sources of reflective, tacit and interpretive knowledge as much as it is from propositional knowledge. These together can contribute to a professional knowledge base that can underpin the range of skills needed by practitioners to achieve expertise in the heterogeneous health care settings of today' (Garbett, 2000, 169).

The knowledge of healthcare is therefore 'messy', in that the field of practice is one where problems may be ill defined and ill structured and it is not always possible to derive clear-cut solutions from abstract principles (Dahlgren, Richardson and Kalman, 2004; Patel and Kaufman, 2000). It is a field of knowledge of many dimensions, which does not fully comply with the forms of knowledge of the natural sciences (Richardson, Dahlgren and Higgs, 2004). And it is one where it is necessary to 'extract something from a messy, complicated, amorphous individual story [of the care of a patient] that is sufficiently clear and well-defined to serve as the raw material of scientific study' (Taylor, 2006, 11).

Implications for the communication chain

This perspective raises some immediate issues for the communication chain. The creation of knowledge since the 19th century has been largely left to biomedical scientists and leading practitioners working in a scientific paradigm. Most practitioners have been content to occupy a role as users of information. The emphasis on practical 'craft' knowledge and on personal knowledge as of equal importance suggests that there is an important role for the 'average' practitioner in the creation of disciplinary knowledge (Garbett, 2004; Richardson, Higgs and Dahlgren, 2004).

Moving on from creation to communication, it has traditionally been the formal, objective propositional knowledge that has been handled in the information chain, through books, journal articles, lecture notes and so on. Practical know-how and personal knowledge have sat uneasily in this environment and have usually been communicated directly or by example. The most obvious mechanism for this has been the 'apprenticeship' system for junior health professionals, involving ward rounds, case conferences and supervised practice. Other recommendations for sharing such knowledge generally revolve around discussions, 'critical conversations', peer review, appraisal of research findings, story-telling, etc. (Richardson, Dahlgren and Higgs, 2004; Titchen, McGinley and McCormack, 2004; Titchen and Higgs, 2000). The advent of the communications capabilities of the internet, and especially of Web 2.0, may tend to move these informal, face-to-face interactions into the realm of published information, with potentially dramatic results for the communication of this kind of knowledge.

Structure of healthcare knowledge

We can now examine in a little more detail the nature of the healthcare knowledge outlined above. It will be immediately obvious that the structure of formal, abstract propositional knowledge will be different from that of the less formal, tacit, personal and practical knowledge. These varied structures will determine, to a large extent, the ways in which such knowledge may be organized, disseminated and accessed. We will concentrate here on some main points of these structures, of particular importance for the communication of medical information.

Propositional knowledge

More attention has been paid to the structure of propositional knowledge, following from its traditionally greater status. This is what is generally regarded as 'medical knowledge', and it includes two aspects: the basic scientific knowledge of the underlying disciplines noted above, such as anatomy, biochemistry and physiology; and clinical knowledge, relating to diseases and their prevention and treatment. It has been conventional to believe that these form a single, integrated 'network of knowledge', in which the basic scientific knowledge 'feeds into' and supports clinical knowledge. This is the basis for regarding the healthcare disciplines as based on the form

of knowledge of the biological sciences, noted earlier in this chapter. However, this view has been challenged on the grounds that clinical knowledge does not always seem, in practice, to be intertwined with basic science. Patel and Kaufman (2000, 42), for example, suggest that 'clinical medicine and the biomedical sciences constitute two distinct and not completely compatible worlds, with distinct modes of reasoning and quite different ways of structuring knowledge. . . . Clinical knowledge is based on a complex taxonomy, which relates disease symptoms to underlying pathology. In contrast, the biomedical sciences are based on general principles defining chains of causal mechanisms'.

Sir Arthur Conan Doyle, like the many medical students who followed the traditional model of first mastering the basic sciences before proceeding to clinical studies, would have agreed with this assessment of the difference between scientific and clinical knowledge, as he wrote that he found his medical studies at Edinburgh in the 1870s 'a long weary grind at botany, chemistry, anatomy, physiology, and a whole list of compulsory subjects, many of which have a very indirect bearing upon the art of healing' (Lellenberg, Stashower and Foley, 2007, 90).

Even in 'clinical' areas, the 'scientific research' view of knowledge may also pose problems for the communication of information: 'Many, if not most, [clinical research journal articles] are written as contributions to clinical research, rather than as attempts to help clinical decision making. This means that even when the information in the article is genuinely useful, it is often written up and presented in such a way that a practising clinician will struggle to find it' (Taylor, 2006, 56).

Patel and Kaufman (2000) suggest that the mismatch between scientific and clinical knowledge may differ in different parts of the knowledge base: clinical knowledge in specialities like dermatology and radiology is closely tied to, and dependent upon, basic anatomical models, while in specialities like cardiology and endocrinology the relation is more distant. Therefore, even within the area of scientific medicine, there is some variation in the exact nature of the knowledge structures. This has implications, for example, for the way in which information may best be indexed or coded. It has even greater implications for attempts to formalize clinical reasoning and hence create useful and cost-effective systems based on artificial intelligence in the medical domain, which has proved a more difficult task than anticipated.

Despite this variation, the extent and significance of which is debated, it is clear that this kind of propositional healthcare knowledge has a clear and consistent structure: it is a complex hierarchy, with many levels (see, for example, Blois, 1984, 1988; Patel and Kaufman, 2000). The levels are linked,

but each has its own 'emergent' properties and entities, which make sense only at that level. At a lower level, for example, one might note a change in molecular structure; at the next level up a change in a biochemical pathway; at the next, a change in cellular structure; at the next, a disease state in a patient; at the next, the epidemiology of that disease in a population. Each of these levels fits into an appropriate taxonomy: chemical, anatomical, microbiological, disease, and so on.

Blois (1984), in an influential book, suggested that a suitable hierarchy for creating descriptions in the medical area would have ten levels (he did not go beyond an individual patient) as follows (using a slightly clearer numbering scheme than Blois' original):

Level 1 – atoms or ions, e.g. sodium ion
Level 2 – molecules, e.g. glucose
Level 3 – macromolecules, e.g. an enzyme
Level 4 – parts of a cell, e.g. cell nucleus
Level 5 – cell, e.g. epithelial cell
Level 6 – part of an organ, e.g. myocardium
Level 7 – organ, e.g. heart
Level 8 – physiological system, e.g. cardiovascular system
Level 9 – major patient part, e.g. chest
Level 10 – whole patient

Another example of the hierarchical structure of this form of healthcare knowledge is given by the illustration of the basic science courses studied at the medial school of McGill University in Canada during the mid-1990s (Patel and Kaufman, 2000). This is illustrated in Figure 1.2 and shows a breakdown from the concept of 'basic sciences', through the sciences themselves, their sub-components, and then to topics within them, e.g.:

Basic sciences
    Physiology
        Cardiovascular physiology
            Cardiac output

Other forms of hierarchy have been developed, but these are sufficient to provide an idea.

This means that the subject is likely to spawn a variety of detailed hierarchical classifications and nomenclatures, which may be used for coding of the occurrence and treatment of disease, for information retrieval and for

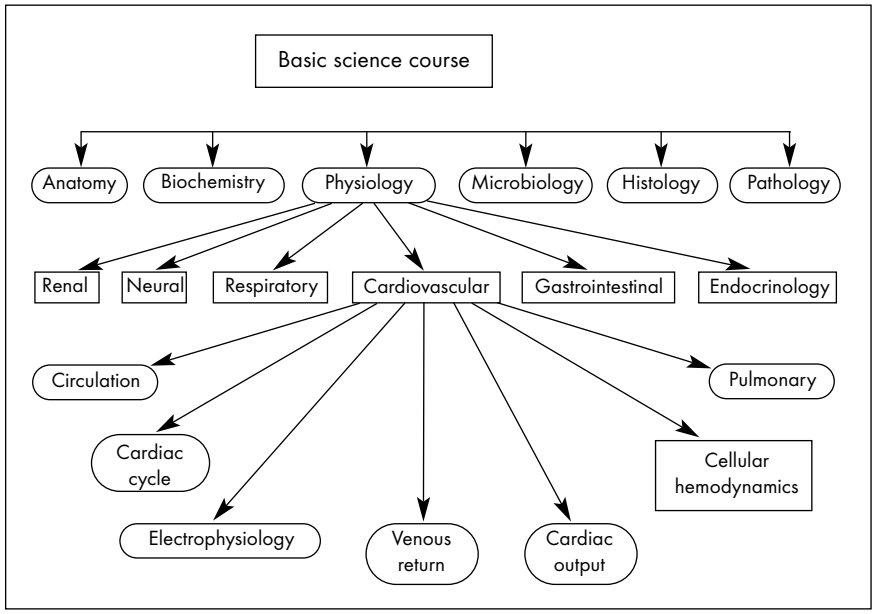

Figure 1.2 A partial model of basic science courses in the medical curriculum at McGill University
Reproduced with permission from Higgs, J. and Jones, M., *Clinical Reasoning in the Health Professions*, 2nd edition, Butterworth Heinemann, 2000.

other purposes. As we shall see later, this is indeed the case. While this is beneficial in allowing the precise communication of information, the existence of numerous overlapping vocabularies leads to a need for 'translation' between them, as we shall also see. It also means that the language of formal healthcare information will be a series of detailed, highly specific terminologies: excellent for communicating meaning precisely, but tending to form a specialist jargon which may be inaccessible to lay people.

Non-propositional knowledge

The other forms of healthcare knowledge, the practical craft knowledge based on experience and the personal 'life knowledge', have been less regarded than formal scientific knowledge, and hence have been less studied. It is clear, of course, that these sorts of knowledge, being subjective, context sensitive and qualitative, will not be amenable to the same kind of detailed, hierarchical structuring as formal, science-based knowledge. Nor will they be amenable to

being classified and coded, and subjected to statistical analysis, nor so readily retrieved from databases using specialized terminology.

Fleming and Mattingly (2000), for example, cite the case of occupational therapists, who typically have good clinical skills and a great deal of tacit practical knowledge, but lack the rich terminology to describe and explain their practice. 'Therapy stories', qualitative descriptions of what was done and why, are a useful way of expressing this sort of knowledge. Titchen and Higgs (2000, 226) also commend story-telling as a way of creating and communicating knowledge, and suggest that all the health professions have knowledge 'hidden away in reflective accounts in the form of stories, poems, diaries and anecdotes'. The value of such methods, necessarily differing in detail for different professions, has been shown by Urquhart (1998).

This emphasizes the extent to which this kind of knowledge will not be effectively communicated through the kinds of structured formats that are suitable for propositional knowledge. Although the above discussion focuses on the tacit and personal knowledge of healthcare professionals, the same will be true of the experiences of patients, carers and other recipients of healthcare, whose knowledge will certainly take this form.

We can see, from this rather superficial survey, that a range of formats and media will be needed to effectively communicate healthcare information.

Scale and scope

'Today's doctor, physician, surgeon, or medical scientist', wrote Morton and Godbolt just before the impact of the internet was felt (1992, 1), 'requires more information than ever before.' No doubt the same would be said confidently today. But the question of how much healthcare knowledge exists is a difficult one to answer. What is not in question is that it is perceived as having a large and rapidly growing knowledge base, and that this perception has been around for many years. An often-quoted suggestion is that the amount of material published has grown exponentially since 1750 (see, for example, Arndt, 1992), and that the amount of available biomedical knowledge doubles every 20 years (Wyatt and Sullivan, 2005). While such figures are difficult to verify, they give an idea of the scale of the problem.

It has been estimated that experienced doctors call upon two million items of information in their practice (Smith, 1996). It is clear that the volume of information is such that it is now impossible for any person to have a full knowledge of even a small area. A full-time postgraduate student working in their area for five years might stand as good a chance as anyone of doing so,

but Prokop (1992) argues that the volume of information in even a single subdiscipline of biomedicine is so great that such a student has no hope of internalizing it all. 'Exogenous memory' in the form of books, databases and other aids is now essential. These aids are themselves now remarkably voluminous. The series of illustrations and example studies below gives an idea of their scale. This is an example of the 'bibliometrics' aspect of domain analysis, albeit presented here in an informal way. We will look at some specific figures for the size of book and journal collections in libraries in Chapter 5.

Journals

Journals remain a pre-eminent source of professional information. It is estimated that between 15,000 and 17,000 biomedical journals are published worldwide, although only about 6000 of these are judged worthwhile for inclusion by the major bibliographic databases MEDLINE and EMBASE (Gray, 2001, 105). The growth of the journal literature is illustrated by the study of Druss and Marcus (2005), which shows that the MEDLINE bibliographic database included 8.1 million items from about 5,000 source journals between 1978 and 2001. Between 1978 and 1985, the average number of articles in MEDLINE was just short of 250,000; from 1994 to 2001, the average was nearly 450,000, an increase of nearly 50%. Nearly 200,000 randomized clinical trials (the 'gold standard' of evidence-based medicine) were published between 1994 and 2001.

The journal literature of healthcare obeys (as do all such literatures) the Bradford bibliometric law of scattering, which shows that, while the bulk of the literature of any given subject will be concentrated into a small number of sources, for a complete coverage a very large number of sources will be needed. Numerous studies of this kind have been published. For example, it has been shown – in two examples of a numerous series of articles on 'mapping the literature' of various aspects of healthcare, published in the *Bulletin* (and the *Journal*) *of the Medical Library Association* – that the literature of occupational therapy is concentrated in 3 journals, but that nearly 900 are needed for completeness (Reed, 1999), while for cytotechnology the respective figures are 3 and over 1000 journals (Stevens, 2000). Half of all papers providing evidence on renal practice were shown in one study to be published in 'non-renal' journals, the authors noting that while scanning top journals in the field is important, 'relevant studies are also scattered across a large range of journals that may not be routinely scanned' by specialists in the area (Garg, Iansavichus, Kastner, Walters, Wilczynski, McKibbon, Yang, Rehman and

Haynes, 2006). The problems are even more acute for a topic which may be of importance to a number of specialities, such a palliative care, where information may be dispersed over many sources (Tieman, Sladek and Currow, 2008).

This scattering phenomenon presents evident problems for any health librarian seeking to provide a comprehensive collection, whether printed or (increasingly likely) digital. It is partly overcome by the increasing availability of large 'bundles' of electronic journals.

Books

Printed books remain of importance, while e-books are of increasing significance, particularly for reference material. To give an indication of the numbers involved, we may consider the following:

- A study of the personal libraries of family doctors in the USA in the late 1990s showed that each kept an average of 56 books in their office. Nearly 3000 different titles were mentioned, mainly prescribing references and textbooks of general medicine (Ely, Levy and Hartz, 1999).
- CILIP's Health Libraries Group produces a regular listing of a 'core collection of medical books'. Its fifth edition, published in 2006, listed 824 books in clinical medicine, limited to recent in-print material, meeting standards of quality and user demand.
- The Royal Society of Medicine (London) library acquires up to 1000 new books each year.
- A US online bookseller offers 90,000 in-print titles in healthcare and biomedical areas.

Online information

The extent of health information on the internet is difficult to assess, as it is more usual to encounter statements such as 'the net is awash with health information' and there are 'massive amounts of health information on the web'. To get some idea of quantity, we can note that the Health on the Net Foundation (HON), a Swiss non-governmental organization devoted to promoting good-quality health information on the internet, estimates that there are four billion (four thousand million) web pages including some form of health information; this is a significant proportion of the whole web, justifying the dramatic kinds of statement quoted above. Of these, HON's

search engine offers access to 140,000 medical websites, and HON promotes 5700 'quality assured' health sites.

Unpublished information

The factors mentioned above relate only to published and generally available information. The information maintained by health services, with a medical record usually available for every person in the population and additional records generated for each episode of healthcare, is also obviously very extensive (see, for example, Taylor, 2006, chapter 2).

Primary care literature

The consequence of this wealth of information is shown in a study of the effort needed to keep up with the literature of primary care, written from the perspective of doctors with particular expertise and interests in epidemiology (Alper, Hand, Elliott, Kinkade, Hauan, Onion, and Sklar, 2004). Their estimate was that over 7000 articles were published monthly in the 341 journals judged to be relevant. They estimated that scanning these for relevance would take over 600 hours per month. To put this into perspective, a study of the reading habits of doctors in the later stages of training (arguably one of the necessarily information-conscious groups) found that they devoted 17 hours per month to the task (Arndt, 1992). Other studies have shown that doctors generate approximately 45 questions about patient care each week (Wyatt and Sullivan, 2005), and that about a third of doctors' time is spent recording and synthesizing information of various kinds (Smith, 1996).

The sheer size of the very large and continually growing body of healthcare information, not to mention its diverse nature, makes its management a challenging task.

Healthcare documents

From the foregoing, it will come as no surprise if we say that, in general, the healthcare domain is characterized by a very large number of documents, of very varied nature, with a wide variety of producers and users, and in a wide variety of languages.

There has been a long-running debate in the information science literature

as to exactly what counts as a document; see Frohmann (2009), and references therein, for insight into this. For our purposes, it is enough to note that documents need not be restricted to text-and-image on paper, or a digital equivalent; other kinds of information-bearing objects may be regarded as documents. Such things as anatomical and pathological specimens, histology slides and so on have been very valuable in the creation and communication of medical knowledge, as have dried herbarium specimens for medicinal botany and herbal medicine; many other examples can be given. This is particularly significant now that such items can be represented in digital form and communicated more widely. The most dramatic example of this is the US National Library of Medicine's Visible Human project, which makes available digital representations of images of the whole human anatomy.

Even in more conventional forms of document, healthcare has long been rich in what would now be termed multimedia documents; it was among the first subjects to combine text and images in printed documents. Images of all kinds, video and animation, maps, diagrams and graphics, sound recordings and interactive presentations all form important aspects of healthcare documentation.

An important distinction between document types, clear-cut in the past, but now being somewhat eroded by changes in the technology of communication, is that between formal and informal communication, and associated documents.

Formal communication

Formal communication may be understood to be that involving materials which are 'published' in some way and hence recorded for posterity and, usually, publicly accessible. It includes documents such as books, articles in journals, magazines and newspapers, reports of many kinds, patents, legislation and regulations, guidance notes and procedures, statistical data compilations, handbooks and formularies, and so on. Originally printed, these kind of documents still form the basis of healthcare communication, though they are now often in electronic form. They generally convey the propositional knowledge discussed earlier in this chapter, though published memoirs, lecture notes and suchlike may also include an element of practical experience, and an attempt to convey tacit knowledge. For overviews of this kind of healthcare and bioscience documentation immediately before the main impact of the internet, see Morton and Goldbolt (1992) and Wyatt (1997).

We may notice that this category includes not only documents intended for

the use of whoever chooses to read them – books, articles, etc. – but also the kinds of documents, noted above, intended for internal use within health services, and hence confidential. The individual's medical record is the most obvious example, but also included here are the clinical, administrative, managerial and financial records of hospitals and other health service units. The restriction of access to these documents to health service personnel (in Britain until the last years of the 20th century it was taken for granted that a person's medical record belonged to the health service, and the patient was not allowed to see it) does not affect their status as 'formal' documents.

Informal communication

Informal communication comprises the transfer of information which is not 'properly published'. This involves face-to-face communication in discussion, teaching and so on that is never recorded in any way, and also the creation of documents not intended for public dissemination: diaries, notebooks, letters and the like. One of the effects of the digital communication revolution has been to allow this sort of communication to happen in virtual environments, and hence to become accessible in a way not possible before. Personal web pages, blogs, wikis, e-mail lists, podcasts, videos on sites such as YouTube, social networking environments such as Facebook and virtual environments such as Second Life are all means by which personal and tacit knowledge, as well as propositional knowledge, can be communicated and can become accessible (see, for example, Boulos, Maramba and Wheeler, 2006; Gustini, 2006; Cross, 2008; Beard, Wilson, Morra and Keelan, 2009; Hendrix, Chiarella, Hasman, Murphy, and Zafron, 2009). These comprise new types of document and can be seen as moving informal communication towards the formal arena. By comparison with traditional, formal documents, they are typically ephemeral, loosely structured, subjective and personal in presentation.

These newer, Web 2.0 tools may of course be used to convey the more formal style of information, but to date this does not seem to happening to a large extent; the two styles of communication seem to be used for different types of information (see, for example, Robinson, 2007).

With traditional, formal communication, documents were produced by a few distinct groupings of authors, particularly:

- scientific and clinical researchers in academia, government institutes, health services, the scientific industry and international organizations
- health professionals (chiefly doctors, and mainly senior personnel)

- managers, administrators and regulators in government and health services and in international organizations
- providers of medicines, equipment and healthcare products
- medical journalists and commentators.

With the new forms of documents now being produced, a wider range of people contribute to the creation of healthcare knowledge. (We should note that technology is not the only reason for this; it is being increasingly recognized that creating and sharing knowledge is a responsibility of all healthcare professionals.) This includes all the groups listed above, plus some others, particularly:

- a wider range of healthcare professionals
- providers of 'well-being' products and services
- patients, carers and recipients of healthcare, both as individuals and as groups.

This has led, on the one hand, to the benefits of more information being more readily available than ever before and, on the other, to concerns about the validity and usefulness of the information to be found in the greater variety of documents produced by a wider range of creators. To take a specific example (suggested by Christine Urquhart (1998)), a specific item, say a blood sugar reading for diabetic patient, may appear in numerous places, including:

- directly in personal blogs, Twitter messages, etc.
- directly in health social networking sites, such as myHealthSpace
- directly in an individual's medical record
- aggregated in trend analysis for an individual
- aggregated, with data from other patients, in a report or journal article on treatment
- subsumed into data in reports, guidelines, etc.

Structures and institutions

The study of structures and institutions within a discipline is an important aspect for domain analysis, as these not only play a major role in forming the nature of the discipline, but also act as important providers of knowledge and information within it. This is certainly so for healthcare, where very many such institutions and structures exist. Most of these are the kinds of institutions

which emerged in the 19th century, with the formation of our modern healthcare system, although, with changing communication patterns, and particularly with the advent of the internet, some have taken new forms.

Many of these will be mentioned later in the book – in Chapter 6 in particular for libraries and information services. Here we will provide a general framework to help understand the area and its information chain, giving a small number of examples for each. Brief information is given for each example, with a web site URL for further information. More details of the services and products offered by these sorts of providers will be given later in the book.

Seven main categories of structures and institutions can be distinguished, though it should be noted that there is overlap between them. Libraries and information centres, for example, may be located within government agencies, professional associations or academic institutions. They are presented here in a rough order of their significance in creating the healthcare knowledge base, with those categories later in the list being largely disseminators and organizers of information.

Academic departments, medical schools, and research institutes

These are the major creators of the scientific and clinical knowledge base of healthcare, through research and scholarship. They are numerous and most countries of the world have such institutions, though basic research is largely still carried out in the West.

Examples of major basic research programmes are the US National Institutes of Health (www.nih.gov) and the British Medical Research Council (www.mrc.ac.uk).

For examples of academic biomedical departments, see the Department of Cell and Development Biology at University College London, UK (www.cdb.ucl.ac.uk), the Department of Physiology at the University of Toronto, Canada (www.physiology.utoronto.ca), and the Department of Pathology at the University of Stanford, USA (http://pathology.stanford. edu).

A listing of medical schools worldwide is provided by World Health Organization (www.who.int/hrh/wdms). As examples, see the College of Medicine and Veterinary medicine at the University of Edinburgh, UK (www.mvm.ed.ac.uk), the School of Medicine at the University of Queensland, Australia (www2.som.uq.edu.au/som), and the Swedish Karolinska Institute (http://ki.se).

National and international institutes and non-profit organizations also

provide much health information, usually in quite specific areas. Examples are the Cochrane Collaboration, an international group providing reviews of the effectiveness of treatments (www.cochrane.org), and the King's Fund, a British charity promoting better healthcare policies (www.kingsfund.org.uk).

The healthcare industry

This industry, and the pharmaceutical industry in particular, is an important creator of information, both on its own products specifically and on healthcare issues generally. We will see in the historical overview (Chapter 3) that there has always been controversy about the involvement of industry in healthcare communication, and this continues with debates on the validity of information provided by industry. As well as manufacturers of products, this sector includes insurance companies and providers of private healthcare.

As examples, see the Association of the British Pharmaceutical Industry (www.abpi.org.uk), and BUPA international health insurance provider (www.bupa.co.uk).

Government agencies and national health services

These have been major forces within the healthcare area for over a century and are among the largest creators of information, both for public dissemination and for internal use.

In the United Kingdom, the Department of Health provides policy statements, and guidance and publications on health and social care (www.dh.gov.uk). Healthcare is provided directly by the NHS (www.nhs.uk). The NHS provides numerous information services for professionals and for the public, including a guide to conditions and treatments (www.nhs.uk/conditions) and advice on health for the general public (www.nhsdirect.nhs.uk). Numerous NHS agencies also provide information for various groups; in particular, the National Institute for Health and Clinical Excellence (NICE) provides the official guidance on best practice in promoting health and treating disease (www.nice.org.uk).

Statistical and demographic data relating to health are also largely provided through government agencies: in the UK through the Department of Health and through the UK Statistics Agency (www.statistics.gov.uk).

Government regulatory agents are also important creators of health information: well known examples are the US Food and Drug Administration

(www.fda.gov) and the international body, European Medicines Agency (www.emea.europa.eu).

Patient and consumer groups

Such groups play an increasingly important role in the creation and communication of information, usually related to a specific health problem, and increasingly provided through the internet.

As examples of the many patient and consumer groups, see the British charities MacMillan (cancer support) (www.macmillan.org.uk) and Diabetes UK (www.diabetes. org.uk).

Professional associations and institutions

Regional, national and international bodies are important creators and disseminators of information to their professional communities, as well major providers of professional education and training. The UK Royal Society of Medicine maintains an extensive list of British and international organizations of this kind.[1] The best known international example is, of course, the World Health Organization and its many agencies (www.who.int). Other examples are the World Dental Federation (www.fdiworldental.org) and the European Society for Therapeutic Radiology and Oncology (www.estro.org).

As examples of national associations, see the British Royal Society of Medicine (www.rsm.ac.uk), Royal Pharmaceutical Society (www.rpsgb.org.uk) and Royal College of Nursing (www.rcn.org.uk), the American Medical Association (www.ama-assn.org) and the Canadian Physiotherapy Association (www.physiotherapy.ca).

Publishers and database producers

These continue to play a vital role in the dissemination of information, though now just as often through websites or e-books as through traditional tools.

As examples of publishers specializing in medical books, see Oxford Medical, Blackwell/BMJ and Thieme Medical Publishing.[2]

As examples of database producers with several offerings relevant to healthcare, see the National Library of Medicine and Thomson Reuters.[3]

For examples of the increasing range of websites offering copious health

information for the public (some from commercial publishers, some from healthcare institutions), see the UK NetDoctor site (www.netdoctor.co.uk), and the American Mayo Clinic's Tools for Healthier Living site (www.mayoclinic.com).

Libraries and information services

Often operated by the kinds of organizations noted above, library and information services play a leading role in the organization and dissemination of healthcare information. Undoubtedly the leading healthcare library in the world is the US National Library of Medicine, which is active in many aspects of research and development into healthcare information, as well as providing a variety of information resources (www.nlm.nih.gov).

A trend is for libraries to adopt a largely digital form, as in the UK NHS Evidence (formerly the National Library for Health) (www.library.nhs.uk); for a rationale for this service, see Leng (2009). For examples of healthcare libraries maintaining both a physical and a virtual presence, see the library of the British Royal Society of Medicine (www.rsm.ac.uk/library), the Hardin Health Science Library at the University of Iowa, USA (www.lib.uiowa.edu/hardin) and the Nursing Library at Yale University, USA (www.med.yale.edu/library/nursing).

Healthcare libraries, of all the sectors of librarianship, have been among the most enthusiastic creators of associations and co-operative groupings. These include local, national, regional and international organizations. Examples of these four types are: CHILL, the Consortium of Independent Health Information Libraries in London (www.chill-london.org.uk); CILIP's Health Libraries Group;[4] EAHIL, the European Association for Health Information and Libraries (www.eahil.net); and the International Federation of Library Associations' (IFLA), Health and Biosciences Libraries Section.[5]

Specialized information services may focus on particular types of information and/or on particular user groups. To show the diversity within this group of services, we can take two British examples. The UK Medicines Information Pharmacists group is an association of pharmacists whose role is to provide information on pharmaceuticals, primarily to other healthcare workers (www.ukmicentral.nhs.uk). The Patient Information Forum is an association for those working with consumer health information, and deals with such topics as the recommendation of relevant information resources and the assessment of the quality of information sources aimed at the general public (www.pifonline.org.uk).

Some providers focus on selecting websites providing 'quality assessed' health information; see, for example, the Health on the Net Foundation, a non-profit organization (www.hon.ch), and the health and life sciences sections of the Intute internet resource directories, supported by the UK higher education community (www.intute.ac.uk).

Drivers for change

A number of factors, very varied in nature, are leading to change in healthcare provision, and thus also in its information communication chain. A brief summary only will be given here, emphasizing the implications for the information chain; for wider surveys see Walton (2000, 2004), Baggott (2004) and Gray (2001). For an example of this issue in, and the difficulties of, analysing current trends in healthcare and predicting the future, see the UK Foresight Health Care 2020 report (DTI, 2000).

Scientific, technical and medical advances have led to improved treatments for many conditions, so that the remit and activities of healthcare services are very different now to how they were in the middle of the 20th century. This, in turn, determines that different kinds of knowledge and information will be needed to support them. These advances have also meant an increase in the size of the knowledge base; quite simply, healthcare practitioners need to know much more than they did in the past. This has led to stronger requirements for practitioners to have good information and IT skills.

These factors are reinforced by an increased emphasis on multidisciplinary teams working in healthcare (Reddy and Spence, 2008), and by an increased internationalization of many health activities, as noted by the British Medical Association (2005) in its recommendations for medical education. This is, of course, accompanied by the need for internationalization of adequate health information (Godlee, Pakenham-Walsh, Ncayiyana, Cohen and Packer, 2004; Madge and Plutchak, 2005).

These advances, among other factors, have led to increased expenditure, and hence to greater emphasis on value for money, this in turn leading to a requirement for better management information. The move towards increasingly evidence-based healthcare also requires improved provision of 'good quality' information. There is also a much greater emphasis on healthcare professionals undertaking continuing professional development, with a consequent need to make use of the evidence base, and to keep up with new knowledge in particular.

Demographic factors, with increasingly ageing populations in Western

countries, are also causing changes in the nature of healthcare, with greater emphasis on the treatment of chronic conditions; this further changes the nature of the knowledge base, with more emphasis on long-term care and support for independent living, and also has added implications for costs. Patient expectations are rising, partly as a general 'consumerist' trend, putting further pressure on services. Healthcare has become an intensely political issue, as witness the intense debates in both the USA and Britain during 2009 as to the best form of state-supported healthcare.

Developments in information technology have a direct impact on healthcare, through decision support systems, information accessible directly in clinical settings, telemedicine and so on. They also help to increase the amount of information available, generally by adding new media rather than replacing the old. The move to a generally digital information environment, as will be emphasized throughout this book, influences all aspects of health information provision; for a commentary on its effect on the health information professions, see Groen (2006).

An increased emphasis on individual choice and responsibility for healthcare, and an increased interest in 'wellness', together with the impact of web-based information, has led to a much more informed public and to the concept of the 'expert patient'. Perhaps as a result of this has come greater emphasis on 'health information literacy', so that people can find the information that is most appropriate and useful for them. The rise of the so-called 'Google generation', used to accessing information instantly via the web, but arguably lacking the skills to interpret it, may exacerbate this problem.

Conclusion

We have seen that healthcare, and its supporting sciences, forms a broad, complex and 'messy' field of practice. Its systems of information communication, which have developed over a very long period, are necessarily equally complex and broad in scope, supporting a large and ever-growing knowledge base.

Notes

1 www.rsm.ac.uk/welcom/linksocs.php.
2 www.oup.co.uk/academic/medicine; http://blackwellpublishing.com/bmj; www.thieme.com.

3 www.nlm.nih.gov/databases; www.thomsonreuters.com/products_services/healthcare.
4 www.cilip.org.uk/specialinterestgroups/bysubject/health.
5 www.ifla.org/en/health-and-biosciences-libraries.

References

AAMC-HHMI (2009) *Scientific Foundations for Future Physicians*, Association of American Medical Colleges, available from www.hhmi.org/grants/pdf/08–209_AAMC-HHMI_report.pdf.

Alper, B. S., Hand, J. A., Elliott, S. G., Kinkade, S., Hauan, M. J., Onion, D. K. and Sklar, B. M. (2004) How Much Effort is Needed to Keep up with the Literature Relevant for Primary Care?, *Journal of the Medical Library Association*, **92** (4), 429–37.

Arndt, K. A. (1992) Information Excess in Medicine: overview, relevance to dermatology, and strategies for coping, *Archives of Dermatology*, **128** (9), 1249–56.

Baggott, R. (2004) *Health and Health Care in Britain*, 3rd edn, Palgrave MacMillan.

Bawden, D. (2002) The Three Worlds of Health Information, *Journal of Information Science*, **28** (1), 51–62.

Bawden, D. (2007) Organised Complexity, Meaning and Understanding: an approach to a unified view of information for information science, *Aslib Proceedings*, **59** (4/5), 307–27.

Beard, L., Wilson, K., Morra, D. and Keelan, J. (2009) A Survey of Health-related Activities on Second Life, *Journal of Medical Internet Research*, **11** (2) e17, available from www.jmir.org/2009/2/e17/HTML.

Blois, M. (1984) *Information and Meaning: the nature of medical descriptions*, University of California Press.

Blois. M. (1988) Medicine and the Nature of Vertical Reasoning, *New England Journal of Medicine*, **318** (13), 847–51.

Boulos, M. N. K., Maramba, I. and Wheeler, S. (2006) Wikis, Blogs and Podcasts: a new generation of web-based tools for virtual collaborative clinical practice and education, *BMC Medical Education*, **6** (41), available from www.biomedcentral.com/1472–6920/6/41.

British Medical Association (2005) *Medicine in the 21st Century – Standards for the Delivery of Undergraduate Medical Education*, available from www.bma.org.uk/careers/medical_education/undergraduate_education/M21C.jsp.

Clough, R. W., Shea, S. L., Hamilton, W. R., Estavillo, J. A., Rupp, G., Browning, R. A. and Lal, S. (2004) Weaving Basic and Social Sciences into a Case-based, Clinically Oriented Medical Curriculum: one school's approach, *Academic Medicine*, **79** (11), 1073–83.

Cross, M. (2008) How the Internet is Changing Health Care, *BMJ*, 337:a883.

Dahlgren, M. A., Richardson, B. and Kalman, H. (2004) Redefining the Reflective Practitioner. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 15–33.

De Gooijer, W. J. (2002) Health Care Systems in Western Europe: an analytical approach, *World Hospitals and Health Services*, **38** (1), 9–12.

Druss, B. G. and Marcus, S. C. (2005) Growth and Decentralisation of the Medical Literature: implications for evidence-based medicine, *Journal of the Medical Libraries Association*, **93** (4), 499–501.

DTI (2000) *Foresight Heatlh Care 2020*, Department of Trade and Industry, available from www.foresight.gov.uk/Health/Healthcare_2020_Dec_2000.pdf.

Duncan, P. (2007) *Critical Perspectives on Health*, Palgrave MacMillan.

Ely, J. W., Levy, B. T. and Hartz, A. (1999) What Clinical Information Resources are Available in Family Physicians' Offices?, *Journal of Family Practice*, 4892, 135–9.

Engel, G. L. (1977) The Need for a New Medical Model: a challenge for biomedicine, *Science*, **196**, (4286), 129–36.

Fleming, M. H. and Mattingly, C. (2000) Action and Narrative: two dynamics of clinical reasoning. In Higgs, J. and Jones, M. (eds), *Clinical Reasoning in the Health Professions*, 2nd edn, Butterworth Heinemann, 54–61.

Frohmann, B. (2009) Revisiting 'What is a Document?', *Journal of Documentation*, **65** (2), 291–303.

Garbett, R. (2004) The Role of Practitioners in Developing Professional Knowledge and Practice. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 15–33.

Garg, A. X., Iansavichus, A. V., Kastner, M., Walters, L. A., Wilczynski, N., McKibbon, K. A., Yang, R. C., Rehman, F. and Haynes, R. B. (2006) Lost in Publication: half of all renal practice evidence is published in non-renal journals, *Kidney International*, **70** (11), 1995–2005.

General Medical Council (2009) *Tomorrow's Doctors*, General Medical Council, available from

www.gmc-uk.org/education/undergraduate/undergraduate_policy/tomorrows_doctors.asp.

Godlee, F., Pakenham-Walsh, N., Ncayiyana, D., Cohen, B. and Packer, A. (2004) Can we Achieve Health Information for All by 2015?, *Lancet*, 364 (9430), 295–300.

Gray, J. A. M. (2001) *Evidence-based Healthcare*, Churchill-Livingstone.

Groen, F. K. (2006) *Access to Medical Knowledge: libraries, digitization and the public good*, Scarecrow Press.

Gustini, D. (2006) How Web 2.0 is Changing Medicine, *British Medical Journal*, 333 (7582), (December), 1283–4.

Hendrix, D., Chiarella, D., Hasman, L., Murphy, S. and Zafron, M. L. (2009) Use of Facebook in Academic Health Sciences Libraries, *Journal of the Medical Library Association*, 97 (1), 44–7.

Henley, E. and Twible, R. (2000) Teaching Clinical Reasoning Across Cultures. In Higgs, J. and Jones, M. (eds), *Clinical Reasoning in the Health Professions*, 2nd edn, Butterworth Heinemann, 255–61.

Higgs, J. and Jones, M. (eds) (2000) *Clinical Reasoning in the Health Professions*, 2nd edn, Butterworth Heinemann.

Higgs, J. and Titchen, A. (2000) Knowledge and Reasoning. In Higgs, J. and Jones, M. (eds), *Clinical Reasoning in the Health Professions*, 2nd edn, Butterworth Heinemann, 23–32.

Higgs, J., Andresen, L. and Fish, D. (2004) Practice knowledge – its nature, sources and contexts. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing practice knowledge for health professionals*, Butterworth Heinemann, 51–69.

Higgs, J., Fish, D. and Rothwell, R. (2004) Practice Knowledge – Critical Appreciation. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 89–105.

Higgs, J., Richardson, B. and Dahlgren, M. A. (eds) (2004) *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann.

Higgs, J., Jones, M., Edwards, I. and Beeston, S. (2004) Clinical Reasoning and Practice Knowledge. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 181–99.

Hirst, P. (1974) *Knowledge and the Curriculum*, Routledge and Kegan Paul.

Hirst, P. and Peters, R. S. (1970) *The Logic of Education*, Routledge and Kegan Paul.

Jippes, M. and Majoor, G. D. (2008) Influence of National Culture on the Adoption of Integrated and Problem-based Curricula in Europe, *Medical*

Education, 42 (3), 279–85.
Lellenberg, J., Stashower, D. and Foley, C. (eds) (2007) *Arthur Conan Doyle: a life in letters*, Harper Collins.
Leng, G. (2009) NHS Evidence: better and faster access to information, *Lancet*, 373 (9674), 1502–4.
Madge, B. and Plutchak, T. S. (2005) The Increasing Globalisation of Health Librarianship: a brief survey of international trends and activities, *Health Information and Libraries Journal*, 22, supplement 1, 20–30.
Mallon, W. T., Biebuyck, J. F. and Jones, R. F. (2003) The Reorganisation of Basic Science Departments in US Medical Schools, 1980–1999, *Academic Medicine*, 78 (3), 302–6.
Morton, L. and Godbolt, S. (eds) (1992) *Information Sources in the Medical Sciences*, Bowker-Saur.
Nutton, V. (1995) Medieval Western Europe, 1000–1500. In Conrad, L. I., Neve, M., Nutton, V., Porter, R. and Wear, A. (eds), *The Western Medical Tradition: 800 BC to 1800 AD*, Cambridge University Press, 139–205.
Nutton, V. (2004) *Ancient Medicine*, Routledge.
Ohio State University (2009) Radiology Program, available from http://amp.osu.edu.
Patel, V. L. and Kaufman, D. R. (2000) Clinical Reasoning and Biomedical Knowledge: implications for teaching. In Higgs, J. and Jones, M. (eds), *Clinical reasoning in the health professions*, 2nd edn, Butterworth Heinemann, 33–44.
Prokop, D. J. (1992) Basic Science and Clinical Practice: how much will a physician need to know? In Marston, R. Q. and Jones, R. M. (eds), *Medical education in transition*, Robert Wood Johnson Foundation, 51–7.
Purdue University (2009) Pharmacy Academic Programs, available from www.pharmacy.purdue.edu.
Quality Assurance Agency (2002) UK Quality Assurance Agency for Higher Education, *Health Studies Subject Benchmark Statement*, available from www.qaa.ac.uk/academicinfrastructure/benchmark/honours/healthstudies.pdf.
Reddy, M. C. and Spence, P. R. (2008) Collaborative Information Seeking: a field study of a multidisciplinary patient care team, *Information Processing and Management*, 4491, 242–55.
Reed, K. L. (1999) Mapping the Literature of Occupational Therapy, *Bulletin of the Medical Library Association*, 87 (3), 298–304.
Richardson, B., Dahlgren, M. A. and Higgs, J. (2004) Practice Epistemology: implications for education, practice and research. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge*

for Health Professionals, Butterworth Heinemann, 201–20.
Richardson, B., Higgs, J. and Dahlgren, M. A. (2004) Recognising Practice Epistemology in the Health Professions. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 1–14.
Robinson, L. (2007) Impact of Digital Information Resources in the Toxicology Literature, *Aslib Proceedings*, **59** (4/5), 342–51.
Robinson, L. (2009) Information Science: information chain and domain analysis, *Journal of Documentation*, **65** (4), 578–91.
Smith, K. A. and Mehenert, R. B. (1986) The National Library of Medicine: from MEDLARS to the sesquisentennial and beyond, *Bulletin of the Medical Libraries Association*, **74** (4), 325–32.
Smith, R. (1996) What Clinical Information Do Doctors Need?, *British Medical Journal*, **313** (7064), 1062–8.
Stevens, S. R. (2000) Mapping the Literature of Cytotechnology, *Bulletin of the Medical Library Association*, **88** (2), 172–7.
Sturgeon D. (2008) Skills for Caring: valuing knowledge of applied science in nursing, *British Journal of Nursing*, **17** (5), 322–5.
Talbot-Smith, A. and Pollock, A. M. (2006) *The New NHS: a guide*, Routledge.
Taylor, P. (2006) *From Patient Data to Medical Knowledge: the principles and practice of health informatics*, Blackwell.
Thompson Rivers University (2009) Nursing courses, available from www.tru.ca/nursing/curriculum.
Tieman, J., Sladek, R. and Currow, D. (2008) Changes in the Quantity and Level of Evidence of Palliative and Hospice Care Literature: the last century, *Journal of Clinical Oncology*, **26** (35), 5679–83.
Titchen, A. and Higgs, J. (2000) Facilitating the Acquisition of Knowledge for Reasoning. In Higgs, J. and Jones, M. (eds), *Clinical Reasoning in the Health Professions*, 2nd edn, Butterworth Heinemann, 222–9.
Titchen, A., McGinley, M. and McCormack, B. (2004) Blending Self-knowledge and Professional Knowledge in Person-centred Care. In Higgs, J., Richardson, B. and Dahlgren, M. A. (eds), *Developing Practice Knowledge for Health Professionals*, Butterworth Heinemann, 110–26.
University of North Carolina Greensboro (2009) Undergraduate Nursing, available from www.uncg.edu/nur.
Urquhart, C. (1998) Personal Knowledge: a clinical perspective from the Value and EVINCE projects in health library and information services, *Journal of Documentation*, **54** (4), 420–42.

Walsh, P. (1993) *Education and Meaning: philosophy in practice*, Cassell Educational.

Walton, G. (2000) Health Services: a contemporary approach. In Booth, A. and Walton, G. (eds), *Managing knowledge in health services*, Library Association Publishing, 3–14.

Walton, G. (2004) New Structures and Principles in Health Services. In Walton, G. and Booth, A. (eds), *Exploiting Knowledge in Health Services*, Facet Publishing, 3–15.

Wear, A. (1995) Early Modern Europe, 1500–1700. In Conrad, L. I., Neve, M., Nutton, V., Porter, R. and Wear, A. (eds), *The Western Medical Tradition: 800 BC to 1800 AD*, Cambridge University Press, 215–361.

World Health Organization (1946) WHO Definition of Health, available from www.who.int/about/definition/en/print.html.

Wyatt, H. V. (ed.) (1997) *Information Sources in the Life Sciences*, 4th edn, Bowker-Saur.

Wyatt, J. C. and Sullivan, F. (2005) Keeping Up: learning in the workplace, *British Medical Journal*, **331 (7525),** (November), 1129–32.

Further reading

Baggott, R. (2004) *Health and Health Care in Britain*, 3rd edn, Palgrave MacMillan.

Blois, M. (1984) *Information and Meaning: the nature of medical descriptions*, University of California Press.

Groopman, J. (2007) *How Doctors Think*, Houghton Mifflin.

Higgs, J. and Jones, M. (2000) *Clinical Reasoning in the Health Professions*, 2nd edn, Butterworth Heinemann.

Taylor, P. (2006) *From Patient Data to Medical Knowledge: the principles and practice of health informatics*, Blackwell.