Health Informatics

Stephen Goundrey-Smith

Information Technology in Pharmacy

An Integrated Approach

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Preface

The purpose of this book is to provide a general introduction to pharmacy information technology at the current time, to discuss issues surrounding the adoption of technology and to discuss how technologies may be utilised by the pharmacy profession to exercise new professional roles and achieve new professional aspirations.

This has been a major project for me as a pharmacist, a health informatician and as a writer, and I would like to thank those whose assistance and support has been invaluable in the production of this book.

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- Fellow members for the Guild of Healthcare Pharmacists/United Kingdom Clinical Pharmacy Association (UKCPA) IT Interest Group Committee

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Chedworth, Gloucestershire, UK Stephen Goundrey-Smith

Contents

1 IT Enabling Pharmacy Practice 1
Introduction. 1
IT in Pharmacy – Purpose and Scope. 2
The Profession of Pharmacy – Past, Present and Future 4
The Development of Clinical Pharmacy 6
The Development of Information Technology in Healthcare. 7
The Benefits of IT in Healthcare 9
The Quest for Intraoperability 9
Coding of Medicines Concepts 11
Medicine Item Codes 15
Electronic Information Sources for Pharmacy and Therapeutics. . . 15
Electronic Drug Databases 18
Information Technology to Support the Medicines Use Process . . . 20
Information Technology to Support Clinical Pharmacy 21
IT and the Interface Between Pharmacy and the Pharmaceutical Industry 22
Clinical Safety 23
Pharmacy IT as a Sociotechnical Innovation 24
Conclusion 25
References 26

2 Electronic Patient Records 27
Introduction. 27
Development of Electronic Patient Records 28
Legal and Professional Framework for EHRs 29
Confidentiality 29
Consent 30
Liability. 30
Information Governance and Data Sharing 31
UK Health Records Standards Initiatives 32
EHRs – Principles of Design and Use 34
What Is an EHR? 34
Systems Used for EPRs 34

Creation of EPRs 35
Access to EHR Systems by Pharmacy Professionals 36
Liability for Record Use 37
Subject Access to EHRs 38
Viewing the EHR 39
Sharing of Data 39
Use of Data for Purposes Other Than That for Which It Was Collected 40
Business Continuity 40
Archiving and Destruction of Records 41
Electronic Health Record Initiatives 41
Benefits of EHRs 45
Clinical Pathways and Content 47
Optimisation of EPRs for Pharmaceutical Care 48
Applications of EPRs for Pharmacists 49
The Content of a Pharmaceutical Care Record 50
Medicines Reviews 51
Medicines Reconciliation 52
Shared Care 53
Long Term Condition Management 53
Homecare Supply 54
Appliances 54
Patient Group Direction (PGD) Supply 55
Public Health and Screening 55
Home Visits 55
Conclusions 56
References 56

3 Electronic Prescribing and Medicines Administration in Hospitals 59
Introduction 59
Benefits of Electronic Prescribing 60
Reduction in Medication Error Rates with EP Systems 61
Effect of EP Systems on Medication Error Rates in Paediatrics . . . 66
Role of Barcodes in EP Systems 67
Increases in Medication Errors due to the Introduction of EP Systems 69
Reduction of Medication Errors due to the Availability of Electronic Decision Support Tools at the Point of Prescribing 71
Problems with Evaluating Risk Reduction Aspects of EP Systems 76
Workflow Management for Clinical Users of EP Systems 78
Discharge Process Efficiency 82
Facilitation of a Seamless Pharmaceutical Supply Chain 83

Reduced Use of Paper and Consumables 85
Clinical System Intraoperability 85
Improvement in Hospital Business Processes due to Electronic Dissemination of Prescriptions 86
Security of Prescriptions and Prescribing Information 88
Quality of Care Benefits 88
Conclusion 89
References 90

4 Pharmacy Automation 95
History and Development of Dispensary Technology 96
Pharmacy Robot Design and Operation 97
Adoption of Pharmacy Automation in the UK 98
Drivers for Use of Automation in Pharmacy 100
Benefits of Pharmacy Robots 102
Evaluating the Benefits of Pharmacy Robots 105
Electronic Ward Cabinets 106
Benefits of Electronic Ward Cabinets 109
Implementation Issues with Electronic Ward Cabinets 110
Remote Dispensing Systems 112
Specialist Dispensing Systems 114
Conclusions 117
References 117

5 Electronic Medicines Management in Primary Care 121
The Development of Systems for Medicines Management in Primary Care 121
Clinical Coding for GP Systems 124
Data Quality in GP Systems 126
GP System Functionality 126
Identifying Patients and Registration 127
Problem and Episode Recording 127
Recording of Allergies 128
Prescribing, Medication Records and Prescribing Decision Support Systems (DSS) 129
Items of Service 131
Pathology Tests 131
Document Management 132
GP to GP Transfer 133
Data Migration 134
GP System Safety and Usability 134
Electronic Transfer of Prescriptions (ETP) 135
Benefits of eTP 136
eTP Functionality Issues 138
Problems with eTP 142

Supplementary Clinical Information 142
Professional Checking..... 143
Substitution 143
Labelling of Prescriptions..... 144
Accuracy Checking 144
Owings and Out of Stock Items..... 144
Dispense Notification 144
Submission of Reimbursement Endorsement Messages 145
Cancellation of Electronic Prescriptions 145
Electronic Repeat Dispensing 145
Data Structure and Product Selection 146
Business Continuity..... 146
Adoption of ETP..... 146
Prescribing Management Software..... 147
Conclusion..... 148
References..... 148

6 Pharmacy Management Systems 151
Introduction..... 151
History and Development of Pharmacy Systems 151
Pharmacy System Requirements and Use..... 152
Pharmacy System Architecture..... 154
Community Pharmacy System Functions 155
Hospital Pharmacy System Functions 157
Stock Control Methodologies in Hospitals 158
Pharmacy System Interfaces 160
Reporting..... 161
Availability of Clinical and Medicines Information Through Pharmacy Systems 162
System Functions 163
Benefits of Pharmacy Systems..... 164
Other Pharmacy Departmental IT Applications 166
Extension of EP Functions from Pharmacy Systems 168
Fridge Temperature Monitoring Software..... 169
Integrated Community Pharmacy Systems 170
Systems to Support Clinical and Enhanced Services in Community Pharmacy 170
Conclusion..... 171
References..... 171

7 Barcodes and Logistics..... 175
Introduction..... 175
Current Pharmaceutical Distribution Processes..... 176
Development of Barcodes and Optical Technology..... 178
Radio Frequency Identification (RFID) 179

The Regulatory Framework for Supply Chain Harmonisation 179
Rationale for Barcode Symbology Harmonisation 181
Benefits of Barcode and Optical Technology in Pharmacy and Medicines Management 182
Patient Safety 182
Security of the Supply Chain 184
Tracking of Supply Chain Efficiency 184
Intraoperability 185
E-Commerce in Pharmacy 185
Reduction of Dispensing Errors 186
Electronic Medicines Administration 187
Pharmacy Workflow Tracking 189
Conclusion 191
References 191

8 Future Prospects in Pharmacy IT 193
Towards Integrated IT Systems in Pharmacy Practice 193
Smart Pumps 195
Oncology Systems 196
Challenges of Device Integration 196
Smart Packaging 197
Telecare and Pharmacy 201
Clinical Homecare 206
Methodology and Evaluation 207
Development of Professional Standards 208
Pharmacy Professional Engagement in IT Adoption 210
IT Education and Training 212
Conclusion 215
References 215

Appendices 219

Index 231

Chapter 1
IT Enabling Pharmacy Practice

Introduction

Over the last 30–40 years, information technology (IT) has revolutionised professional life for millions of people around the world. IT has reduced the need for bulk storage of paper records by organizations due to its capacity to store large amounts of digital data on hardware which is relatively small in size. Also, because IT systems can copy, process and disseminate data, and present data in different ways, computers have been able to automate tasks that were previously repetitive and labour-intensive, and carry them out in a fast and accurate way. For these reasons, the expansion of IT into the workplace – and indeed, the home – has completely changed working practices in many industries. IT has enabled economies of scale, improved efficiencies and enabled new ways of working that were hitherto impossible. The use of IT means that services can be provided to large populations, yet customised to each individual. Computers have had a major impact on many industry sectors including banking and finance, retail, the service industries – and healthcare.

In parallel with the rise of IT during the last 40 years, the role of the pharmacist – and the society in which pharmacists work – has changed considerably. Pharmacists are no longer principally compounders of medicines, as most medicines now are available in a suitably packaged form from manufacturers. However, pharmacists are still responsible for ensuring that the patient receives the correct medicine, ensuring that the patient understands why they should take their medicine, and helping the patient with taking the medicine and being concordant with therapy.

Modern medicines are becoming increasingly sophisticated in terms of their modes of action, so the information available about them is correspondingly more complex. Furthermore, the amount of medicines information available has increased exponentially, with information now available through a range of different providers. Traditionally, information on medicines was available in reference sources – pharmacopoeias and compendia – produced by specialist publishers and professional bodies, and also from the pharmaceutical industry. Today, however, medicines information is available from a plethora of sources on the internet.

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However, information provided over the internet will not be subject to the same quality processes and review mechanisms as information in the traditional medicine reference sources so, in some cases, this information may be biased or of questionable quality. A key issue is how the most appropriate information on medicines can be made available in the most readable form to the patient or healthcare professional at the point of care.

The increasing availability of medicines information direct to the patient, as with internet sources, means that information on medicines is no longer the sole preserve of the healthcare professional. There has also been an increase in the growth of consumerism in healthcare, with a corresponding reduction in paternalism on the part of the healthcare professional. People therefore see themselves as consumers of healthcare rather than patients. While, in fomer days, the doctor's advice was the final authority and was not questioned, now the patient will simply find a different clinician if they don't like the advice they receive. The concepts of the "empowered patient" and the healthcare professional as "a partner" with the patient in the healthcare process are now in common use among healthcare policy makers.

A combination of new medical technology and new information technology means that public health needs can now be identified and addressed in a way they could not in previous generations. And with the full understanding of public health issues, and the ability to address them, comes the ethical imperative to do so, with the corresponding pressures on health professional activity and healthcare provider budgets. Pressing public health issues, and their budgetary impact, especially in the deprived sections of the population, are huge drivers for the development of new professional roles in healthcare and the use of IT to enable these roles in both the United Kingdom and the United States. At the time of writing, the NHS in the UK is undergoing a far-reaching programme of reforms, which will have considerable impact on the efficiency of healthcare provision but, more subtly, on the relationship of different professional groups and how they might work together to optimise healthcare provision in the NHS. The UK NHS needs to realise huge cost savings in healthcare delivery – to the tune of approximately £20 bn – and many managers and clinicians recognise that these cost savings will only be realised through the use of IT systems in healthcare delivery, with the reduction of risk, increase in efficiencies, and the new ways of working that they enable.

IT in Pharmacy – Purpose and Scope

The book will describe some of the benefits and risks associated with the use of IT to support the provision of a pharmacy service, and some of the issues that pharmacy managers implementing these technologies face. The book will also explore the way in which current and emerging technologies might support new ways of working in pharmacy, to make the most of the pharmacist's skill set. IT applications that support the work of pharmacists in hospital and community pharmacy practice will be described and discussed, drawing on the author's experience and available

research literature in the field. The emphasis will be on the holistic use of technologies to streamline and influence the prescribing and medicines use process, and so the book will look at IT systems that are not, or not solely, used by pharmacists, such as hospital electronic prescribing systems and the systems used in doctors' surgeries (GP systems).

Chapter 2 will look at the development of electronic health records, and the design, security and legal issues associated with them, and how the electronic health record can enable and optimise high quality pharmaceutical care. Chapter 3 will examine the benefits of hospital electronic prescribing (EP), the experiences of implementation and how it affects pharmacists. Chapter 4 discusses the various forms of automated dispensing that have been developed, including dispensary robots, ward cabinets, remote dispensing kiosks, and other forms of dispensing device. Chapter 5 will review the use of IT systems in the wider primary care arena, including general medical practitioner's systems, electronic transfer of prescriptions (eTP), and prescribing management systems and will describe the functions of these systems from a pharmacy perspective. Chapter 6 will examine the role of patient medication records in community pharmacy, and departmental pharmacy systems in hospital pharmacy, looking at their functions and their contribution to pharmacy management. Chapter 7 reviews the development of pharmacy logistics and how IT has impacted on this, particularly in the area of product and batch identification. Finally, Chap. 8 assesses potential future developments in IT to support pharmacy practice, together with the standards in education and professional development that will be required to capitalise on these.

The book will discuss the use of IT in pharmacy practice from an international perspective, looking at literature describing innovation and practice from different countries – most notably, the United States, UK, Europe and Australia.

The scope of the book does not extend to a full discussion of:

- The editorial and distribution processes for distributing reference sources on pharmacy and clinical medicine (eg formularies and monographs)
- The medicines information systems used purely to support the activities of the pharmaceutical industry
- Databases and systems used for the capture and storage of clinical trial data.

However, the discussion will touch on these areas to the extent to which they relate to the practice of pharmacy. The book describes pharmacy IT in general terms and is not intended to be a substitute for professional advice or consultancy in a specific practice setting.

As well as a discussion of the impact of technologies on pharmacy practice, this book will also discuss the issues surrounding the adoption and use of technology, the engagement of the pharmacy profession with technology, and the policy and standards that should underpin the use of technology by pharmacists. An exhaustive literature review of IT applications in pharmacy is beyond the scope of this book, although the book will refer to key research papers. Also, many of the IT applications and systems discussed are interrelated and there is an extent to which the division of the subject matter between the chapters is arbitrary.

In order to discuss the information requirements of the pharmacy profession and the role of IT in the working life of the pharmacist, it is necessary to review the history of the pharmacy profession [1], and the environments in which the profession operates.

The Profession of Pharmacy – Past, Present and Future

The profession of pharmacy emerged in the UK during the early nineteenth century, with a gradual distinction developing between apothecaries on the one hand, who were essentially medical practitioners, and chemists and druggists on the other, whose prime occupation was the preparation and supply of medicines. Some of these chemists and druggists were also apothecaries, others members of the pepperer's section of the Guild of Grocers and still others with no trade affiliation. However, following the Apothecaries Act of 1815, the activities of apothecaries were increasingly regulated, and there was a concern that, in emerging legislation, chemists and druggists who did not wish to become apothecaries would become subservient to the apothecaries. Consequently, a number of chemists and druggists decided to form a professional association to ensure that their interests were best served, and that they remained an independent group. The Pharmaceutical Society of Great Britain (Royal Pharmaceutical Society) was formed in 1841 for this purpose and soon established the legal basis for a register of pharmacists and a designation of pharmacist as a restricted title.

In Victorian times, in both the US and UK, pharmacists largely sold medicines rather than dispensed doctors' prescriptions (at that time pharmacists dispensed less than 10 % of prescriptions written by doctors in England and Wales). Furthermore, at this time, medicines were made of crude plant or animal extracts, and were of limited efficacy and often dubious quality. Many were produced in individual pharmacies according to a proprietary formula (secret recipe) of the pharmacist's choice. Consequently, during the early years of pharmacy, there was a large number of medicines available of variable formulae and quality and there was very little information available on these medicines, other than that compiled for advertising purposes.

In the UK, the 1911 National Insurance Bill signalled a change in how health services were provided, with a significant impact on the pharmacy profession. The National Insurance legislation established a national insurance scheme for those in employment, which provided free medical care – and medicines – for those contributing to the scheme. Previously, anyone consulting a medical practitioner would have paid a fee for the consultation, and a fee for any medicine prescribed at the consultation from the doctor's own dispensary. Under the national health insurance scheme, doctors would write prescriptions, which pharmacists would have the right to dispense. Because of the need for national health scheme reimbursement, the role of the doctor as prescriber and of the pharmacist as dispenser were separated. This had two effects. Firstly, it established a need for doctors and pharmacists to

communicate about the dispensing of prescriptions. Secondly, there was a sharp increase in the percentage of doctors' prescriptions dispensed by pharmacists from around 10 % (as previously mentioned) to around 40 %. Income from prescription remuneration therefore became a major source of income for a pharmacy business. Local committees were established to process national health insurance scheme remuneration and a national Drug Tariff was introduced to standardise medicine prices and prescription payment processes.

These far-reaching changes in healthcare were further extended by the establishment of the National Health Service (NHS) in 1948, which aimed to provide free medical care (and medicines on prescription) to every citizen, not just those in employment.

The development of the welfare state in the UK, through the national insurance legislation of 1911 and the NHS Act of 1946, was the impetus for national standardisation of formulated medicines, and the availability of standard information on these medicines. As mentioned previously, in Victorian times, there had been a plethora of chemist's remedies of variable formula and quality available from pharmacies. However, following the introduction of the national insurance scheme in 1914, local reimbursement committees were urged not to pay for medicines with a "secret formula". This led to the development of a national formulary in 1929, which provided standard formulations for commonly-used unbranded medicines. This was the forerunner to the British National Formulary, one of the standard medicines reference sources in use today.

While the activities of the Pharmaceutical Society of Great Britain ensured that pharmacy began to emerge as a profession in the mid nineteenth century, pharmacists were still businessmen and a number of issues faced by pharmacists in the UK at that time related to their trade interests as much as to their professional standing. In 1880, a court action established a precedent that it was permissible for a corporate body to own multiple pharmacy premises. This was regularised in law in the 1908 Poisons and Pharmacy Act. This enabled the growth of multiple pharmacies in the UK, such as Boots, which had been established in 1877. There was therefore an increasing need for pharmacies to communicate with other branches of the same company, as well as with doctors and with their customers and patients.

Following the establishment of the NHS in 1948, the percentage of doctors prescriptions processed by the NHS rose to around 70 %, which is the figure at the current time. The formation of the NHS also therefore led to a reduction in the sales of proprietary medicines from pharmacies. However, while these trends might have been negative ones for pharmaceutical manufacturers, the industry was in a strong position with many new medicines being developed in the twentieth century "therapeutic revolution", and there was increased advertising activity for all medicines. A reaction to this was increased regulation of the medicine development and marketing process and the development of the Association of the British Pharmaceutical Industry Code of Practice on the advertising of medicines, introduced in 1958 [2] . These developments increased the amount of information on medicines available in the public domain, although many professionals have been concerned about how unbiased some of the information was. More

recent developments on evidence-based medicine, such as the development of reviews such as the Cochrane Centre and National Prescribing Centre publications such as MeReC have attempted to ensure that balanced, evidence-based medicines evaluations are available to the health services.

Nevertheless, despite their "special" status, medicines are regarded in legal terms as ordinary items of commerce, as far as trading is concerned. In 1952, Boots the Chemists Ltd wanted to introduce self-service trade for medicines, which was already prevalent in the US, but the Pharmaceutical Society objected, arguing the medicines were not ordinary items of commerce, like other goods. This led to a High Court action in 1953, where the Pharmaceutical Society's argument was dismissed as protectionism, and which established that medicines could be traded in the same way as any other goods.

From the mid 1980s onwards, the policy direction of community pharmacy has been towards extended roles beyond dispensing. The 1986 Nuffield Report advocated extended roles for pharmacists, and the 1992 report, *Pharmaceutical Care: The Future of Community Pharmacy* made some important recommendations to support extended roles, such as:

- Pharmacists should maintain medication records for their patients
- Pharmacists should have consultation areas on their premises
- There should be a greater range of medicines available for sale over the counter to support pharmacy consultations and counter prescribing.

During the early twenty first century, these developments have largely been implemented in community (retail) pharmacy in England. Furthermore, a range of new services have been introduced in UK community (retail) pharmacy in the UK. These include the medicines use review (MUR), for reviewing medicines in the pharmacy, introduced under the 2005 English pharmacy contract, local enhanced services, which may include smoking cessation, needle exchange for intravenous drug users and minor ailments services, and, most recently, the new medicines service (NMS) for patients starting medicines for long term conditions. All of these have requirements for information management and storage, and processes have been developed to support pharmacists delivering these services.

The Development of Clinical Pharmacy

Critical to the explosion of information available on medicines, and the consequent need to systematise, store and retrieve that information has been the development of clinical pharmacy. An increase in the range of scientific techniques and processes available to the pharmaceutical industry, together with greater financial resources in the boom years after the Second World War led to the "therapeutic revolution" in the pharmaceutical industry with many innovative groups of medicines being developed, such as phenothiazine neuroleptics for schizophrenia, beta blockers for hypertension and angina, and H2 antagonists for gastric and duodenal ulcers. This led in

turn to an increase in the amount of research literature and information available to prescribers. The greater number of medicines available, and the greater amount of information about them meant that hospitals had to adopt new procedures for the administration of medicines (the use of medicine charts (Kardexes) and drug trolleys) and that hospital pharmacists were increasingly required to provide advice on the use of medicines to doctors and nurses, rather than simply supply the medicines. In the UK, the 1953 Linstead Report recommended the involvement of hospital pharmacists in medical decision making and the 1958 Aitken Report stated that hospital pharmacists were responsible for safe and secure handling of medicines in the whole hospital, not just in the pharmacy department.

This led to the gradual development of clinical pharmacy, which may be defined simply as a pharmacy service at the patient's bedside, i.e. in a patient focussed manner. The US led the way with the development of clinical pharmacy services, such as near-patient pharmacy services, therapeutic drug monitoring and clinical specialism in pharmacy.

In the UK, the 1970 Noel Hall Report recommended a restructure of the hospital pharmacy service to make a better use of pharmacists' skills and recommended more research and development within hospital pharmacy. This led to the development of regional and district drug (medicines) information centres in the late 1970s and 1980s, providing a range of paper and electronic information sources on medicines, to support pharmacy practice and clinical pharmacy [3]. This has in turn led to routine post-graduate clinical pharmacy qualifications for hospital pharmacists, increased specialisation of pharmacists in different areas of medicine and therapeutics and the presence of clinical pharmacists, along with clinicians and nurses, on hospital wards rather than in the pharmacy department, during the 1990s. Ward-based, near-patient clinical pharmacists in UK hospitals today are often part of multidisciplinary teams and are supported by medicines management pharmacy technicians.

Information technology has already been developed to facilitate the processes of labelling, dispensing and supplying medicines, and to maintain patient medication records. Software applications are now available to deal with prescribing and medicines management beyond the dispensary, and many pharmacists are aware of, and are actively using, these applications. IT therefore has considerable potential to support pharmacists in future clinical roles, and to enable new approaches to pharmacy practice, as the twenty first century continues.

The Development of Information Technology in Healthcare

With the advent of solid state technology, where for the first time it was possible to build computers that were powerful enough to handle large volumes of data with optimal speed, but small enough to be of practical use in a working environment, organisations began to see the potential of computer-based systems to replace paper records of different sorts.

Within healthcare, the first major area of IT use in the 1970s was the collection and storage of patient data on a single computer to enable a healthcare provider to maintain electronic patient records, for administrative purposes. However, from around 1975 onwards, computers began to be used to automate manual, routine procedures and activities in US hospitals and clinics, and thus began to have a greater impact on clinical care. Assisted by the development of modern communications and networking technology, healthcare IT applications began to be integrated into larger, more sophisticated systems, which offered a range of functions to users within the organisation [4]. A pioneer of the move to bring computerised healthcare closer to patients was the John C. Lincoln Hospital in Phoenix, Arizona [5].

Consequently, over the last 30 years, systems have been developed to manage specific activities in hospital wards and departments. The most well-developed IT applications in secondary care have been pathology systems, for the management of test results, and pharmacy systems, for the labelling of dispensed items and for pharmacy stock control. Systems such as these were relatively straightforward to implement from a technical perspective, as they had their hub in one particular department of the hospital, and this department therefore had control over the implementation. However, the installation of a hospital departmental system represented a major change in working practice within a department, and had to be managed with care from a change management perspective.

In primary care, some clinicians actively embraced computer technology once personal computers were small enough for desktop use. However, the memory capacity of these early machines was limited and the coding of medicine concepts was necessary to enable large quantities of patient information to be stored in machine readable form. For this reason, Read codes were developed in the UK for coding medical terms on GP computer systems, and became pivotal in management of information in primary care. Coding systems also provided a common language so there was the potential for communication of information between systems in different practices, and production of comparable activity reports for a number of practices in a locality.

GP systems have been in use since the mid 1980s and offer a range of functions to support the working practices of GPs/primary care clinicians. These include storage of information on diagnoses and medical history, prescribing functions, provision of decision support functions for prescribing (interruptive DS for allergies, drug interactions etc, and availability of medicines reference information at the point of prescribing), pathology order management and items of service/billing and claim management.

Computers have been available to support prescribing in primary care for many years, and there is therefore considerable experience in this area, whereas the use of computers for prescribing in hospitals is at a much earlier stage of adoption. However, while GP systems were available to enable prescribing in medical practices back in the 1980s, their integration into the routine working practices of GPs has been much slower. By 1996, only one in four doctors were actually using their GP system in the course of a patient consultation [6].

The Benefits of IT in Healthcare

The main driver behind the adoption of IT in healthcare has been the various benefits that IT can provide for the organisation. Automated systems offer advantages over traditional paper-based systems in three main areas:

- Accuracy – automated systems can support the consistent use of medicine nomenclature, the accurate recording, display and transmission of prescription information, and the accurate display of clinical warnings as a result of a logical system of trigger points. Computers therefore are able to automate repetitive processes or monotonous processes which are prone to human error when carried out manually [7]. Thus automated systems are able to reduce clinical risk for the healthcare provider. An example of this is the use of IT to ensure accurate selection of medicines, where errors might arise from manual picking due to similar names, packs etc (see Fig. 1.1)
- Standardisation of data – automated systems allow patient data to be captured and stored according to standard formats and conventions. This facilitates the electronic transfer of patient data, and the production of comprehensive management reports. The production of management reports by hospitals and healthcare providers is an issue of great political significance in many healthcare economies where there is a need for governments and the public to be aware of healthcare issues and outcomes, and for healthcare providers to report on activity to payors and insurers. Furthermore, in standardising patient data, electronic systems therefore have the capacity for what has been described as "mass customisation" [7]. In healthcare terms, this means that, although the system handles large amounts of patient data, it is able to produce an individual care plan based on the specific personal requirements of each patient, thus supporting the personalisation of patient care in a consumerist society.
- Facilitating changes in working practices – automated systems have the capacity to process prescription information accurately and at scale, and are able to facilitate the display of that information in different contexts, according to system design and hardware availability. They are therefore able to make possible new ways of working for individuals and organisations. Because the system takes care of the routine recording, computational and transmission aspects of prescription information management, organisation processes may be restructured so that health professionals can engage with near-patient clinical activities, which require intuitive human qualities.

The Quest for Intraoperability

However, the issue facing all users of healthcare systems is that of their intraoperability. This has particularly been an issue in secondary care where a hospital has, historically, had a number of computer systems – a PAS, a pathology system, a pharmacy system, a radiology system – offering reliable functionality, but operating in parallel,

Fig. 1.1 Medication safety. Different medicines may have similar pack designs, which can cause dispensing errors; automated systems are able to avoid these errors

in a "silo" fashion, with no connectivity between them. This presents a number of problems – (a) duplication of effort in the design and configuration of functions that may be common to all systems (e.g. patient selection functions), (b) duplication of staff effort in data entry onto the systems, (c) introduction of risk due to all elements of a patient record not being visible to a user through a single system.

In many hospitals in the UK and US, a whole-hospital patient administration system (PAS) or hospital information system (HIS) has been installed, together with order communication systems, which deal with the messaging of orders in the broadest sense (e.g. radiology orders as well as pathology and pharmacy orders). However, these systems have traditionally relied on interface software to enable the central system to communicate with individual departmental systems. These interfaces are often complex to build and may themselves introduce data communication errors, and so require rigorous testing.

To enable systems to be truly intraoperable, standard data coding formats and terminologies are required so that healthcare applications will have a common database platform and can communicate in a common language. A number of standard coding systems, developed principally to record health events for public health purposes [8], can enable this as far as use of medicines is concerned. These include ICD 10 codes and DRG codes, Read codes and SNOMED CT codes, the HL7 terminology scheme and, specifically for medicines, the UK dm+d schema, which was developed as the basis of the UK NHS Connecting for Health applications.

Intraoperability has been a key aspiration of a number of regional and national healthcare IT systems, for example, the systems developed by US healthcare management organisations (HMOs) such as Kaiser Permanente, the UK NHS IT programmes, and schemes in Sweden [9] and Italy [10]. However, appropriate coding methodologies, and a willingness of all stakeholders to work towards an integrated system are essential to realise this goal. To understand current intraoperability issues with pharmacy IT and to appreciate the potential of future systems if data standards are incorporated, it would be helpful to have a discussion about the various coding schemas available for concepts associated with the prescribing and supply of medicines.

Coding of Medicines Concepts

If systems are to capture, store and transmit information about prescribing and medicines management, they require data schemas that will describe the concepts relevant to the prescribing and pharmacy domains. These would include:

1. Allergies
2. Medicine details (drug, strength, route etc)
3. Details of medicine administration duration
4. Current Diagnosis
5. Previous Medical History
6. Side-effects,

The discipline of health informatics has developed to analyse and systematise health and disease related information and, with time, a number of clinical coding systems have evolved to describe health and medicine concepts in a machine-readable manner [11]. Many of the coding systems have their historical origins in the need to classify and enumerate medical events for public health purposes. Many of these have relevance to EP systems and are discussed below.

The International Classification of Diseases (ICD) is a multiple axis disease classification schema which is published and administered by the World Health Organisation. It is now in its 10th revision (ICD 10), but the process is in place for developing the 11th revision [12], which will resolve issues such as usability on web-based systems and integration into electronic health records.

This schema has its origins in the work of William Farr, the first medical statistician for the General Register Office of England and Wales, in the mid-nineteenth century. He saw the need for a classification system for diseases to enable mortality statistics to be collected on an ongoing basis. Initially the schema was designed to record causes of death, but was subsequently developed to list diseases and disorders causing considerable morbidity. The classification continued to be used for the pragmatic purpose of collecting epidemiological data, and is currently used by WHO for making international comparisons of health statistics. The schema is therefore a practical classification, rather than a theoretical one, and it may require adjustments to allow finer levels of detail to be expressed in certain applications.

ICD 10 coding is often used as the coding system for diseases and diagnoses assigned to patients in electronic medical records, and would be the point of reference for medication management systems giving contraindication/precaution checking or drug-disease interaction checking, based on patient record information. ICD-10 codes are of particular concern in applications where there is a clear requirement for production of reports or statistical returns. An example of this would be oncology systems for the management of oncology and haematology clinics, where there is a major political need to report epidemiological data. In the UK, this is facilitated by the agreed National Cancer Data Set, which was established to eliminate reporting inconsistencies between different UK Cancer Registries [13]. The National Cancer Dataset is due to be replaced in 2012 by the Cancer Outcomes and Services Dataset (COSD), which will include the cancer registry dataset, and other site specific data items [14].

Diagnosis Related Groups (DRGs) were developed in the US by the Healthcare Finance Administration as a means of assigning a cost of treatment to a patient's diagnosis. They were developed to enable calculation of Medicaid reimbursement costs. DRGs are based upon ICD Clinical Modification (ICD-CM) codes in ICD 9 or ICD 10. Appropriate ICD codes are refined by placing them in diagnostic categories and then grouping them into subgroups that reflect consumption of resources, criteria for treatment, and potential complications. Thus patients are assigned a DRG from a relatively small number of DRG codes. DRGs are used routinely in the US and have been adapted in other countries where a reimbursement algorithm has been required. They are designed for hospital inpatients and do not provide a suitable means of assessing the costs of chronic disease care. Availability of a DRG designation for a patient, together with actual medicine cost data from an EP system may permit a variance analysis of projected costs and actual costs of inpatient treatment within the US context.

Read Codes (subsequently called Clinical Terms) were developed in the UK to enable clinicians (mainly in general practice) to code events in the electronic patient record, and thus enable statistical auditing of the patient care process in primary care. Read Codes have latterly been owned and administered by the UK government. Read Codes have changed considerably both in their terminology and in their structure during their lifespan. Version 1 of the Read Codes was a strictly hierarchical schema. In version 2, the structure was changed so that they more closely approximated ICD 9 disease codes and OCPS 4 procedure codes. Version 3 of the Read Codes was, in contrast with v1, a compositional schema, where each term could be augmented by qualifier terms.

While Read codes have been used extensively to code for diagnosis, problems and medicine prescribing in GP systems in the UK, they have not been used routinely in secondary care applications, largely because they were developed for primary care use. A key issue in the use of Read Codes has been the increasing potential for lack of concept control with combination terms, in the latter versions. However, many GP systems map prescribed medicines to their respective Read Codes, and Read Codes may therefore have a role in facilitating communication between primary care and secondary care systems in the UK.