Preface

INTRODUCTION

A wide variety of definitions of health informatics are available, from the intensely technical “application of computer science and technology to public health” (Yasnoff, et al., 2000), to the patient-centred “methods for acquisition, processing and interpretation of patient data, information, and knowledge” (Imhoff, 2001). From our viewpoint, informatics is the study of the creation, capture, management, and application of information for scientific and/or business gain. Health Informatics relates to the systematic use of information and information analysis and problem-solving techniques for the purpose of improving medical and health intervention activities. The combination of humans and technology that acts to create, capture, and process data, information, and knowledge can be viewed as an information system. By understanding how such a system can capture, process, and disseminate information efficiently and effectively, and deliver it to the right people, processes, and technology for effective decision making at the right time, health intervention, and care performance goals can be met. By efficiency, we refer to the minimisation of effort and resource in the intervention activities, both in human and machine terms. Effectiveness relates to how well the specified goal of the activity or process is met. Achieving efficiency and effectiveness requires an understanding of the information lifecycle, the development of information from data, and the application of knowledge as information in context to enable action decision-making. Whilst much informatics research focuses on processing of information by technology, we must also include the behaviour of the prime user and processor of information, the human. Healthcare is relatively unique in placing a human (as a patient) at the centre of an action or an information-intensive process. Unfortunately, the human’s very existence may be threatened not only by their medical condition but also by the very actions of other humans and resources attempting to intervene to improve that condition.

PATIENT SAFETY

Patient safety is concerned with avoiding accidental harm (iatrogenic injury) and ensuring the patient is cared for in an optimised and minimum-risk environment. Recently, there has been a rise in iatrogenic industries in health systems from a variety of sources. We use the term health systems to refer to the combination of people, information, processes, and technology (equipment resources) that are applied to carry out actions and provide services within a health environment. A complete health system may be viewed as the interaction between three information sub-systems: informal, formal, and technical in an organisational containment model (Hall, 1959; Stamper, et al., 2000).
Technical systems refer to automated information systems, equipment, devices, and machines. Technical systems enable the automation and execution of human plans, actions, and information processing, as well as the provision of data, information, and knowledge for decision making. Formal systems refer to arrangements of policies, processes, procedures, and behavioural rules constrain and ideally enable the planning and control of safe and quality actions. Finally, the informal system, by which people decide to behave, act, communicate, and socially control the health service work environment, is the final arbiter of what happens in the health environment and how it is viewed.

The drivers of accidental injury or risks to patient safety may usefully be divided into these informal, formal, and technical areas. Technical drivers refer to technology as a designed system of resources. Technical drivers can range from drug resistance problems with antibiotics systems through operational equipment problems, poor design (Reason, 2000, 1998). Formal drivers relate to design, planning, control, and training problems with policies, plans, procedures, and rules of action. Informal drivers include human behaviour and human factors. Informal drivers are concerned with problems of human behaviour and their interactions with resources. This encompasses human factors (Holden, et al., 2011; Carayon & Gurses, 2008), communication (Haig, et al., 2006), culture, personal behaviour, environmental factors, informal actions and events, and decisions that may negatively impact patient safety and quality outcomes. This strongly relates to Reason’s slips, skill, rule, and knowledge-based errors (Reason, 2000) that occur because of human actions or inactions (see Figure 1).

Figure 1. The three dimensions of informatics and key drivers of safety issues (adapted from Stamper, et al., 2000; Hall, 1959)
QUALITY

Patient quality may take many forms. We define quality as a system’s performance to specification. For patients, the specification often means the unwritten (informal) social expectation of how they will be treated and their experience of staff behaviour. This is in addition to what many typically see as the embodiment of quality, the formal specifications of the care and treatment processes and the technical operating specifications of technical resources, equipment, and information. However, whilst formal specifications and performance measures exist widely, it is often the small acts of personal service and informal behaviour that meet the unwritten patient and co-worker quality expectations. Hence, we must consider informal quality measures in terms of behaviours and personal and cultural norms as well as the rules, KPIs, and metrics of formal and technical systems that together can maintain the quality of integrated health systems (see Figure 2).

Quality significantly relates to the experience of the patient in their treatment in healthcare environments and particularly the performance of the healthcare organisations in meeting and exceeding these written and unwritten perceived health quality specifications and levels of care delivery. This covers both tangible and intangible combinations of healthcare products and services in the broadest sense. However, often the human patient in the loop is neglected in favour of formal and impersonal key performance indicators and metrics (Mid Staffordshire, 2013). This book interprets safety and quality through the informatics lens of:

- Informal dimensions referring to the quality and safety issues inherent in human interactions and informal information systems

Figure 2. The three dimensions of quality

- Attitude and Behaviour
- Social norms
- Team Norms
- Cultural norms
- Policy
- Clinical pathway
- Procedure
- Algorithm
- Equipment specification
- Drug specification
- Consumable specification
- Intervention specification
- Formal dimensions referring to safety and quality issues involved in the codified care process and formal information systems, under management by medical institutions, medical teams, and individuals
- Technical dimensions relating to automated complex and focused technology systems and techniques that enable formal and informal actions.

**Pervasiveness of Data, Information, Knowledge, and Quality**

Ultimately, all human and technology action is dependent on formal and informal data, information, and knowledge to specify and control the actions in practice. The way these actions are specified and executed in informal, formal, or technical practices to meet the health action goals will determine the quality of the outcome for the patient and the health organization (see Figure 3).

**Objective of the Book**

This book aims firstly to bring together a range of current thinking on health informatics applied to the needs of patient safety and quality. We explore wide ranging recent and on-going work that positively impacts patient safety and quality outcomes. The book includes both theoretical and best practice models, approaches, and thinking that pragmatically aim to meet the patient quality and safety needs. Our second aim is to set people thinking about the pervasive nature of information and innovative use of informatics in all aspects of healthcare. For this reason, we have included works in progress and developing concepts to encourage researchers and academics to build on this cross section of existing research and develop

*Figure 3. The pervasiveness of information and quality*
new research and best practices. We have deliberately sought out a wide variety of chapter subjects to highlight the wide range of innovative health informatics subjects in order to both educate and enthuse our reader audience about the opportunities for health informatics in the future.

TARGET AUDIENCE

The target audience of this book includes professionals, clinicians, and researchers working in the field of medicine and medical informatics that are concerned with quality and patient safety. In addition, educators and trainers at undergraduate and postgraduate and post experience levels that wish to develop and apply the ideas to their training of clinicians and health workers in order to improve quality and safety of the patient deliverables.

This book makes no apology for the extensive inter- and multi-disciplinary nature of health informatics ranging from social to highly technical interactions and from deep theory to highly pragmatic solutions. The pervasiveness of information makes interdisciplinary understanding of informatics in all its forms a necessity. We hope we have shown by example the range of contributions from working clinicians to academics and the need for this collaboration.

We also hope the nature of the book will influence the development of inter-disciplinary relationships, research teams, and courses of study at undergraduate and postgraduate level (such as that being developed by the authors) that link healthcare to the study of informatics and technology and its application to enhance the quality and safety dimensions of medical practice and tomorrow’s healthcare.

BOOK STRUCTURE

Section 1: Patient Safety – The Human Interface

We start the book with the human dimension and the realm of informal systems in informatics. It is above all the human in the loop that ultimately leads to errors in quality as a result of human inattention, poor cognition, and attitude. However, it is also the intelligence, compassion, and understanding of that same human that both fills the gap in patient safety and contributes to its quality as perceived by the patient. This section includes chapters that identify the various human factors that contribute to safety issues, the behaviour of humans, and the use of technology to improve training and manage personal issues such as privacy and dignity.

- Natalia Sarenko discusses the issue of patient privacy and develops a framework to identify how psychological, informational, and physical privacy can be evaluated and improved to support patient quality. Chapter 1 describes how these types of privacy are important to service quality and patient safety, due to the recent advancements in information and telecommunication technologies, and the availability of online medical information. Moreover, the framework proposes that these privacy dimensions affect trust in a healthcare provider, which in turn has an effect on treatment compliance, positive word-of-mouth, and commitment to engage with the current service in the future.
• In chapter 2, Deborah Rosenorn-Lanng and Vaughan Michell present a model, titled “SHEEP,” to identify quality and safety factors relating to near misses. The model allows frequency of risk factors and their impact to be analysed at a departmental or institutional level, which enables a structured focusing of resources at an organisational level.

• In chapter 3, Deborah Rosenorn-Lanng considers the concept of non-technical skills and how deficiencies in this arena can result in medical error. The content provides a brief overview of the five domains of non-technical skills, which are particularly useful when working in teams: team, decision making, task related, situational awareness, and information. When considering information, the text considers the importance of understanding read back, active identification, and cross checking.

• Mel Humphries and colleagues explore the use and opportunities for virtual learning environments as a training and simulation tool for collaborative learning to improve patient safety. Chapter 4 details a collaborative teaching and learning evaluative project between Nursing and Midwifery, Pharmacy, and Medicine at Keele University, to explore the development of team working skills (NOTECH), allowing debrief within an inter-professional active virtual learning environment to enhance patient safety.

Section 2: Patient Safety – The Process Interface

This section focuses on formal behaviours in terms of safety and quality approaches to health process and activities. Processes as sequences of activities are the mechanism by which patient interventions are organised and particularly how care for their safety is coordinated and managed over time. However, in many ways, the understanding of process and the place of informal behaviours and activities in relation to technical tasks is poorly understood in healthcare. Many of the best practices in industry are rarely seen or applied in the health environment. The chapters in this section suggest ways of applying informatics techniques and best practices to safety and quality in health intervention processes.

• Sarah Jane Jones and Mairi Macintyre explore the challenges of defining and measuring patient safety. The chapter is intended to highlight to the reader why safety currently is not well measured. Chapter 5 presents current systems thinking, concerning patient safety, and explores what patient safety actually means, allowing a foundation for a critical review of tools used for safety measure-ment. The author’s consideration ranges from hard measures to softer cultural perspectives, thus ensuring that the patient view is not forgotten.

• Nada Nadrah and her colleagues explore the concept of deviations from formal work processes as “workarounds” and their manifestation in health services. The authors examine how workarounds have evolved with the development of health systems (i.e. their motivation and types) and present a discussion concerning the positive and negative impact of workarounds on health safety and quality. Workarounds are increasingly prevalent due to the lack of human flexibility and timeliness of technology, rising complex demands, and increasing competing calls for clinician attention. Chapter 6 content is based on primary research and exploratory workaround cases from interviews and analysis of 14 staff in three hospitals.

• Jasmine Tehrani describes in chapter 7 how errors mainly occur as a result of human defects or poor system and procedure design. The author presents a method for generating clinical pathways from a semiotic perspective, which can address social and informal/safety factors that conspire to-
gether to influence the outcome of patient interaction and safety. The method captures knowledge across multiple information levels and guides the modelling of clinical pathways using Business Process Modelling Notation (BPMN) best practices.

- Weizi Li examines patient safety issues in practical treatment processes caused by the ineffective use of clinical pathway knowledge. By considering healthcare knowledge management, and a discussion of clinical pathway knowledge management patterns, chapter 8 describes how knowledge management can enhance the implementation of clinical pathways to achieve medical quality improvement.

## Section 3: Patient Safety – The Technology Interface

This section focuses on the range and use of technology enablers in developing a safety positive health environment. Whilst these will inevitably lead to increasing cognitively complex demands on already overworked clinicians, they are also part of the evolving solution of applying technology to augment and assist the clinical decision makers that are ultimately responsible for patient safety. This chapter provides examples of how technology can assist the informal social and formal environments of patient safety.

- Peter Hawrylak and his colleagues discuss the technical application and use of Radio Frequency Identification (RFID) devices as a cheap and relative easy-to-use technology to reduce stress and error in capturing medical information. Radio Frequency Identification (RFID) technology enables wireless communication between a RFID reader and a RFID tag, which can be carried by the patient. The authors argue that by making the system simple, and by using an intuitive human machine interface, the duration of the visit (throughput) can be decreased. Accordingly, they explore in chapter 9 the use of passive RFID tags to store medical information about a patient, with specific focus on storage of a child’s vaccination history.

- Kevin Yap explores technical patient safety issues regarding the problem of identifying predictors of adverse drug reactions in cancer patients. Pharmaco-cybernetics supports clinician use of drugs through the combined use of computational technologies/techniques and human-computer-environment interactions. The advent of pharmaco-cybernetics has led to the development of various software, tools, and Internet applications that can be used by healthcare practitioners to deliver optimum pharmaceutical care and health-related outcomes. Chapter 10 provides a good example of interdisciplinary insight. By applying pharmaco-cybernetics technology to reducing drug problems and hence improving patient safety and quality, this aims to increase the awareness amongst healthcare professionals and clinician-scientists concerning the usefulness of such techniques in clinical patient populations.

- Ken Eason and Patrick Waterson’s chapter explores the range of technical solutions and social issues of patient safety and community care relating to the growing concern regarding a globally ageing population. Chapter 11 reviews a number of technologies used for this purpose: tableware, telehealth, telemedicine, electronic patient record systems, and technologies to support mobile working. In addition, the authors provide an examination of attempts to implement major changes in the service delivery of integrated care, showing that e-health technologies can be successfully implemented when they are seen as an intrinsic part of the creation of a complete system.
• Patrick Palmieri and colleagues discuss how healthcare organisations are increasingly willing to adopt Health Information Technology (HIT) to enhance efficiency, yet technology failure often occurs, namely iatrogenesis. Chapter 12 proposes a healthcare iatrogenesis model to guide organisations in a responsible implementation of HIT projects. By recognising the cause of failure and anticipating patient safety concerns, the authors claim that leaders can proactively respond to system limitations and identify hidden process instabilities prior to costly and consequential catastrophic events.

**Section 4: Patient Safety – The Information Interface**

Information is pervasive and always with us. It is the basis for identifying and providing a window into both who and what we are and how and why we behave as we do. Clinicians face ever-increasing information overload; yet limited research is devoted to identifying the form and features of clinical data, information and knowledge structures, and how the information dimension impacts patient safety and quality. More focused and considered information is needed. This section focuses on how information and its characteristics can be harnessed to problems of specifying and managing the quality of human care at the informal, formal, and technical levels.

• Technology-enabled processes to help patients to provide information to aid diagnosis can help improve patient life quality and their healthcare experience and reduce safety risks. The employment of Virtual Reality (VR) and mobile computing in everyday healthcare is anticipated to foster future delivery of services. In chapter 13, George Ghinea and his colleagues present the results of a usability study that makes use of an Android-based handheld device for investigating disabled users’ performance in using an intuitive interactive VR interface for pain assessment. It is anticipated that due to the portability and good visualisation ability of the application, it will offer many advantages over current methods, thus improving pain assessment practices and the patients’ ability to communicate their experience.

• Lawrence Chidzambwa’s chapter focuses on the role of telecare and how inclusion of information and knowledge regarding social considerations can improve the formal telecare process design and patient safety and quality aspects. Chapter 14 proposes a normalised home telecare framework that offers a guide to social factors that must be considered on which a telecare solution design should be based. It provides a means of ensuring take up of telecare devices to improve patient quality of life and safety. The authors discuss how service outcomes in telecare should be based on individual cases, and should consider user experience from both clinical and social points of view. The proposed framework provides method of structuring the captured social aspects and applying them to the solutions, allowing an improved understanding of the objectives and provider capabilities.

• Basel Khashab and colleagues discusses how Customer Relationship Management (CRM) solutions might be used to create value for patients by supporting trust and service creation. With increased levels of patient empowerment, the authors focus on a need to consider CRM from a strategic perspective (i.e. linking the problems of customer-focused care expectation and resource allocation management). Chapter 15 highlights a need for a common and systematic way to implement a CRM solution in the healthcare domain.
In chapter 16, Patcharin Wannatawee and colleagues consider literature from the areas of technology acceptance and chronic care self-management, which aims to alleviate symptoms and/or reason for non-acceptance of care and thus minimise the risk of long-term complications. By bringing these areas together, the authors highlight techniques to flag patients whose self-management is failing. Not only does this allow us to understand non-acceptance, it allows us to reengage patients, which in turn reduces the chance of spiraling health/expenditure.

Section 5: Architecture, Strategy, and Policy

Section 5 is made up of research into how the health service architecture and strategy impacts patient safety and quality (health enterprise architectures, strategic issues, and patient safety).

In chapter 17, Chekfoung Tan and Shixiong Liu explore the need to provide pervasive healthcare services and information. Pervasive healthcare aims to provide healthcare services to the right people in the right physical location at the right time by integrating seamless healthcare service provisions, such as primary care, secondary care, and home care. This integrated care will support single view care (i.e. integrated care from general practitioners, hospitals, and home care providers), via a Pervasive Healthcare Information Technology (PHIT) architecture. PHIP ensures that healthcare services are supported by the appropriate information and technical infrastructures to maximise patient care. Such provision will aid clinicians in obtaining appropriate and real-time information by accessing the electronic patient record, thus supporting decision-making and healthcare services.

Stephen Gulliver and colleagues discuss how healthcare provision is significantly impacted by the physical space. Chapter 18 proposes the use of organisational semiotics as a set of methods to link stakeholders to systems, which allows capture of data concerning clinician activity, information transfer, and building use. Moreover, the authors suggest the need for a semantically enhanced Building Information Model (BIM) to link clinician activity to the physical resource objects and space, thus facilitating feedback and persuasive mechanisms.

Wendy Currie presents a longitudinal study looking at the National Care Record Service, which aims to provide 50 million UK (English) citizens with an electronic health record. Using episodic interviewing techniques over ten years and secondary source material, the findings reveal a series of IT policy changes to the original programme. Chapter 19 observes how the original, centralised, top-down policy approaches were replaced over time by localised IT procurement and implementation; however, continuous IT and policy changes only serve to risk this success.

One of the key issues affecting patient quality and safety is obtaining an accurate view of facts and information when needed. We currently stand at the cusp of rapid and wide-ranging technology developments in micro and nano electronics, such as in the development of software and the Internet of things. Vaughan Michell discusses the opportunities for new ubiquitous computing technologies, with concentration the Internet of Things (IoT), to improve patient safety and quality. Chapter 20 explores how the Internet of Things and the ability to add smartness to passive objects can provide fuller, more relevant, and accurate facts, information, and reasoning to improve patient service quality and safety by focusing on elective or planned surgical interventions, although the technology is applicable to primary and trauma care.
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