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Review

A review of Primary Care Informatics: past progress, present reality, future prospects

Abstract: Primary care informatics is beginning to find its feet as a scientific discipline, as evidenced by the increasing number of scientific papers published on the topic over the last three years, particularly those trying to establish the features that distinguish primary care informatics from health informatics more broadly. This paper provides a review of over a hundred scientific papers relating to primary care informatics, and speculates on future directions for primary care informatics.

Introduction

Does primary care need its own health informatics subspecialty? What makes primary care distinctive and different from other specialties in health care, and what effect do those differences have on the information needs of primary care practitioners and their patients?

Primary care has been defined by Starfield as follows:

> "Primary care … is the basic level of health care provided equally to everyone. It addresses the most common problems in the community by providing preventive, curative, and rehabilitative services to maximize health and well-being. It integrates care … and deals with the context … Primary care is distinguished from other types of care by clinical characteristics of patients and their problems … Primary care practitioners are … distinguished from their secondary and tertiary counterparts by the variety of problems encountered … primary care is the first point of contact with the health system" [1].

The distinguishing attributes of primary care services have been identified by the Institute of Medicine as: accessibility, comprehensiveness, co-ordination, continuity and accountability [2]. The information needs of primary care health professionals, and hence the informatics solutions which will best support them, are increasingly being studied, and this paper outlines progress in the nascent field of primary care informatics over the last three years, as evidenced by papers published in that period. A number of distinct themes emerged from these papers, and they are discussed below.

Themes

Theory of primary care informatics

There were only two papers on theoretical aspects of primary care informatics. A paper from Finland outlined the theoretical structure of a health information system and the way in which it might be used to support both patient care and secondary requirements for clinical data [3]. The paper by de Lusignan [4] proposes a definition of primary care informatics, discusses the core concepts and theory, and begins the debate to justify the existence of primary care informatics as a subspecialty of health informatics. At the *Medinfo 2004* conference in San Francisco in September 2004, more than fifty primary care informaticians gathered to continue this debate, and a report will be published in *Informatics in Primary Care* early in 2005.

Implementation studies

There were many more papers looking at a variety of implementations in a variety of primary care settings, reflecting the different ways in which health systems are organised worldwide. Some are evaluations of specific implementations [5,6,7,8,9,10], including across Australian primary care [11] and in the UK prison service [12], while others take a retrospective look comparing primary care with other health sectors [13,14]. They all stress the importance of clinical involvement, leadership and management commitment to the success (or otherwise) of the implementations. Others consider cultural and other barriers, looking at

both the unintended consequences of rapid introduction of new technologies in an insufficiently prepared environment [15], and the difficulties caused by fragmentation of both primary care and the systems available for use within it [16].

Bridging the digital divide

A few papers emerged looking at the use of informatics tools within primary care in the developing world: in India, the World Health Organization's Health InterNetwork pilot project has shown that national and international partnerships can use information and communication technologies to strengthen the public health system and bridge the digital divide in health [17]; in Africa, the implementation of a simple electronic medical record system in a rural Kenyan health centre has bridged the "digital divide", though the authors note that its future use and development will depend on its financial and technical sustainability [18].

A related theme looked at informatics in primary care and underserved populations in the USA, the richest country in the world. One study [19] considered levels of access to IT in physician offices and found that primary care offices located in poor and minority communities in a large, suburban county in California had high levels of access to and interest in web-based systems, and the authors suggest that online services might be made available to poor and minority communities as a way of trying to help improve health outcomes; they do not claim generalisability of these findings, however. Chang *et al* report [20] on the findings of the American Medical Informatics Association (AMIA) 2003 Spring Congress, which intended to develop a framework for a national agenda in information and communication technology to enhance the health and health care of underserved populations. The report emphasises the need for changes to funding mechanisms, partnerships, and education and training on the benefits to be derived from informatics solutions.

Computer uptake and usage

Some studies directly considered uptake and usage of computers: this type of study has largely ceased in many European countries, as almost all primary care physicians' offices have used clinical computer systems / electronic medical records for some years now (such as the UK, the Netherlands, Denmark, Sweden). The study from Carney *et al* [21] considered usage by the educators of tomorrow's doctors in the USA, and found that rates of computer access and internet connectivity were high among community-based preceptors of all ages. Unexpectedly, they also found that there was more, rather than less, use of specific online clinical and/or educational resources among older preceptors.

A study in Scotland [22] found that most primary care doctors and nurses routinely used clinical computer systems for a variety of purposes relating directly to patient care; their staff had less than ideal access, however.

The use of the computer in the consultation was also examined: one ingenious study [23] looked at the effect of computer use on the patient-centredness of the consultation by analysing output from three-channel video using simulated patients. It concluded that achieving a high-quality electronic medical record might be at the expense of patient-centredness. A second study [24] examined doctor–patient rapport by detailed analysis of videotapes of real consultations; this study found three types of clinician behaviour: 'controlling' the consultation by choosing when to use the system, 'responsive/opportunistic' – using the system when suitable without disturbing the rapport with the patient, and 'ignoring', when engrossed in computer use. The authors conclude that there is a major need for training doctors in how to incorporate computer use within the consultation as part of communication skills training.

Comparing paper-based with electronic medical records

Two studies from the UK addressed this theme, and interestingly came to somewhat different conclusions. The study looking at completeness of computer records [25] found that hybrid systems of primary care record keeping documented higher numbers of consultations than computer-only or paper-only systems, and that the quality of individual consultation recording is highest in paper-only systems. However, the other study [26] found that paperless records were as rich in detail as hybrid paper/electronic systems, and furthermore that use of paperless records only did not reduce the amount of information doctors recalled about specific consultations.

Going paperless

Two UK papers looked at the process of 'going paperless'; it is a major change in the way the practice is organised, and needs commitment from the whole practice team to make it successful. The first paper [27] used a questionnaire method to establish the status of practices in a regional research network, and the second [28] is a commentated case study about the process in one practice.

Data quality

The quality of data recorded in clinical computer systems is a major theme in British papers in the last three years; it is an important area in an environment where clinical computer systems are routinely used in delivering

direct patient care. A number of studies set out to measure data quality using a variety of methods; one systematic review [29] found that measures of sensitivity were highly dependent on the type of data being investigated, while the positive predictive value was consistently high, indicating good validity. Prescribing data were generally of better quality than diagnostic or lifestyle data, though it was noted that the lack of standardised methods for assessment of quality of data in electronic patient records makes it difficult to compare results between studies. A second systematic review [30] looked only at diagnostic data, and recommended that the focus should be on ways of helping practices improve data quality. Williams [31] demonstrated a method of scoring completeness and currency of coded information relevant to the management of diabetes, and a further nine papers [32,33,34,35,36,37,38, 39,40] considered methods of doing just this, and most concluded that feedback backed up by targeted educational interventions were effective in improving data quality.

Secondary uses / users of data and information

High-quality data are also important for other purposes: clinical audit, clinical governance, contractual obligations, health needs assessment, public health, epidemiology, commissioning of services from other health sectors, research, and national health statistics. Several papers looked at these other uses of primary care clinical data; again, almost all of these papers originated from the United Kingdom, where high-quality data deriving from direct clinical care is becoming routinely available. Some papers [41,42,43] cautioned against constraining the data recorded in order to satisfy the demands of secondary users, two looked at the requirements of the new General Medical Services contract in the UK [44,45], two considered the needs of other parts of the health service [46,47], and one looked at the needs of genetic research [48].

Support for quality improvement

Using informatics solutions to support improvement in the quality of health care has been a dominant theme over the last three years; several papers consider the power of the electronic medical record [49,50,51,52,53] in enabling such improvement. One UK author [54] suggests that primary care has much to teach other health sectors about the use of clinical computer systems for quality assurance and quality improvement. Other papers demonstrate the efficacy of primary care electronic medical records in improving care particularly for chronic diseases: asthma, congestive heart failure, depression and diabetes in the USA [55,56], coronary heart disease, diabetes and rheumatoid disease in the UK [57,58,59]. One study evaluated a cross-sector system for emergency care [60], and stressed the importance of clinical leadership, education and training, and good analytical tools in implementation. One study [61] looked at the way in which feedback and educational interventions about data quality and information management supported clinical governance and quality improvement in primary care.

Decision support

A more technical set of papers consider the role of decision support in supporting primary care. Most indicate the need to appreciate the complexity and uncertainty of primary care: there is considerable resistance to what is sometimes seen as 'cookbook medicine'. Implementation of decision support systems, even when integrated with a routinely-used electronic medical record, has not been straightforward, and has not always produced improvement in the quality of either the process of care or clinical outcomes. Most studies have looked at the management of chronic diseases as the most likely to render success [62,63,64] but few have shown major improvement; issues include relevance and accuracy of reminder or alert messages [65], lack of flexibility with patients with comorbidity [66], workflow integration [67], terminology and architecture [68], and interface design [69].

Successful decision support implementations were demonstrated in situations where there was little clinical doubt about intervention required, for example a number of studies about medication following diagnostic tests [70,71,72] and stroke patients using risk factors to support treatment options [73], but even these require considerable educational intervention to ensure agreement with the content of the clinical guidelines implemented. One study [74] considered the complex process of translating clinical knowledge into electronic guidelines and the pitfalls that might prevent successful use in clinical practice.

Patient safety

Patient safety is another area of increasing concern in a number of countries. Informatics solutions can help prevent adverse events, and the costs (including legal costs) associated with them. Studies in this area include awareness of clinicians about patient safety [75], the effects of event monitoring and natural language processing tools [76], physician order entry [77], alerts and warnings [78], prescribing safety features and the assumptions made by clinicians about them [79], and the potential for improvement in such features [80]. However, some studies acknowledged that there are risks associated with informatics solutions, in that they themselves are potentially the source of error [77,81,82].

Clinical concepts and coding

All the papers in this area were from Europe; although an enormous amount of activity has occurred over the last three years on the development of SNOMED-CT between the USA and the UK, no papers have been published in Medline-listed journals about it.

A high-level conceptual paper [83] describes a European pre-standard for a "system of concepts and the terms defined in this European pre-standard designed to support the management of health care related information over time, and the delivery of relevant health care by different agents, encompassing primary care professionals and teams, health care funding organisations, managers, patients, secondary and tertiary health care providers, and community care teams". Two papers describe a comparison of Clinical Terms Version 3 and Read Code 5-byte set (84] as well as the methodology used to make the comparison [85].

Clinical communication

Two papers from Scotland review the electronic communication of clinical data to primary care, one looking at rapid access to laboratory results [86], and the other studying electronic discharge information [87]. These studies should be instructive for health systems looking to integrate clinical data across sectors and from different sources.

Security and confidentiality

Informal discussions and conference workshops over the last few years have revealed many concerns among clinicians about the increased scope for sharing of clinical information across health sectors, and the dangers inherent in such sharing, but there are just two academic papers on security and confidentiality, both from the UK, where integration of electronic medical records across the whole health service is rapidly being implemented. One paper considers digital identity and privacy [88], and the other reviews the use of clinical data from primary care for research [89].

Education and training

Although education and training is mentioned in other papers as a necessary part of implementation, only three papers are specifically about the topic. They all focus on different sorts of education and training: one looks at teaching the teachers, working with residency faculty on improving their informatics skills [90], one looks at interventions focused on change management to help facilitators in general practice working on improving information management skills [91], and one looks at the effects of computer training and management support [92].

Professionalism

Increasingly, health informatics is being seen as a career, and attracts a wide variety of people from a range of disciplines, from computer programmers and systems analysts through educationalists, psychologists, sociologists, ethnographers, ergonomists, statisticians and health analysts, to clinical professionals. There is a need for professional and ethical standards for this field of work, and two papers from senior health informaticians consider the issues and potential solutions, particularly within primary care [93,94].

Patient access to the electronic medical record

Patients are increasingly being involved in their own health care, especially at primary care level; a number of studies have looked at the issues arising from patients having access to their electronic health records. A review paper [95] considered characteristics of the record that might enhance or mitigate patients' use of their records: environmental pressures, physician-centredness, collaborative organisational culture, and patient-centredness. The authors propose a framework to assess the suitability of existing record systems for adaptation for patient access. Another 'framework' paper [96] outlines the potential cost-effectiveness of using patient-driven computers to more closely identify at-risk patients and then to implement prevention and health promotion activities for those patients.

A British study [97] looked at the experience of patients in one practice who were given access to their electronic medical record while at the practice. Most patients found viewing their record useful and understood most of the content, although medical terms and abbreviations required explanation; however, they were concerned about security and confidentiality. Some errors were found, though they were mostly not medically significant. Patients wanted the option to add personal information.

Another British study [98] used web access to an interactive electronic medical record for patients as part of the management of their diabetes. Six themes emerged from this study: feeling that non-acute concerns are uniquely valued; enhanced sense of security about health and health care; frustration with unmet expectations; feeling more able to manage; valuing feedback; and difficulty fitting the programme into activities of daily life.

An American study [99] implemented a health-behaviour program in ten practices for use directly by patients. Only one practice managed to make the program work effectively as a component of routine care, though most of the problems experienced by the other nine practices were due mainly to organisational factors rather than problems with the program itself, although all ten practices were highly motivated.

Internet and other ways of communicating health information

Several papers from the USA and the UK considered different aspects of the effect of various internet technologies on patients in primary care. One considered the impact of the internet on the GP–patient relationship [100], two looked at internet consultations and other communications with patients [101,102], two looked at attitudes to and experience of email consultations in general practice [103,104], and three [105,106,107] looked at characteristics of people using the internet for health information and what kind of information they were seeking, and considered what the role of primary care might be in supporting patients in their quest for health information.

A series of papers has been published over the last three years from a team in the UK looking at use of touch screen kiosks by age and gender [108], and digital TV as a modality for providing information to patients in a variety of categories: they reported on characteristics of users and non-users [109], amount and frequency of use [110], what sort of information was used and satisfaction with it [111], and usage of programmes about pregnancy [112].

One paper from the UK [113] examined whether email was a suitable tool for carrying out research in general practice: a simple questionnaire was emailed in late 2001 to the four-fifths of GPs who were known to have NHS email addresses at that time, and the response rates and reasons for non-response were assessed. The authors concluded that at that time email would not be successful as a way of getting GPs to send data for research, as it was not a technology with which they were comfortable. If this study were repeated now, three years on, the results and conclusions would probably be very different.

Recommendations for strategic action

There were several papers (six from the USA, five from the UK and one from Canada) advocating the need for action at a strategic level to ensure uptake of electronic medical records across health communities, or even whole countries – or warning that strategic actions being taken might have unintended consequences.

From Canada came an eloquent plea for more investment in "information systems so vital to the integration and co-ordination of primary care" [114]; this plea might have been heard, according to announcements at *Medinfo 2004* about 'Infoway' [115], the new Canadian health information infrastructure.

From the United States, two papers emerged from the Primary Care Informatics Working Group of the American Medical Informatics Association, advocating the need for a funding infrastructure to support primary care informatics (the practitioners, research, education and the electronic medical record) [116], and outlining a strategic plan for implementation [117]. The National Alliance for Primary Care Informatics wrote in more detail about the need for and barriers to implementation of a primary care electronic medical record [118]. Two papers from mainstream medical journals recognised the potential of electronic medical records to improve primary care and streamline its delivery, but also recognised some of the barriers that need to be overcome [119,120]. Finally from the USA came a consensus conference report, which concluded that: "Improving the safety, quality, and efficiency of health care will require immediate and ubiquitous access to complete patient information and decision support provided through a National Health Information Infrastructure (NHII)." [121] This, of course, holds true for the whole of health care, not just primary care.

The position in the UK is very different, where primary care electronic medical records have been available and extensively used for the last 15–20 years, and the rest of the health service is about to implement an NHS Care Records Service across the whole of health care, integrating patient-centred information across the whole health service. This ambitious programme will have far-reaching effects on all health care providers, and there is increasing concern about it in primary care as a whole, not just in informatics circles. Three papers [122,123,124] extolled the benefits of using whole-systems and/or complexity theory approaches to inform the implementation issues for this programme. An editorial [125] in the *British Medical Journal* gave a general practice perspective on ways of improving information technology across the whole NHS (and also recommended the need for increased clinician involvement in the Programme), and, finally, David Markwell [126] mused amusingly on the need for those knowledgeable about the benefits and successes of informatics to get involved as critical friends, rather than predicting doom for primary care informatics.

The future for primary care informatics

There is an enormous amount of implementation activity in a number of countries, and much of it is about enhancing clinical communication between health care providers. Primary care informatics has a great deal of experience to share about 'what works'. This is not only technical programming expertise but more particularly experience of the factors

that affect the success or failure of an implementation: factors like clinical involvement, high-level managerial support, education and training, workflow analysis and business process redesign (and support for such activities). Primary care informatics has been successful in many countries because of the pragmatic, multi-disciplinary nature of the teams that work in primary care, and the recognition of the benefits of team-working. It has had its own journal for many years, relaunched in 2002 as *Informatics in Primary Care* [127], and now listed in Index Medicus.

It could also be postulated that the nature of the health system also heavily influences the development and use of information technology in primary care: the more fragmented the health care system, the less likely it seems to be that informatics solutions are implemented and used. The benefits of implementing electronic medical records across all health care providers are many: enhancing the quality of patient care and patient safety, as well as providing a wealth of clinical data for secondary uses like clinical audit, health care planning, national statistics, resource allocation, research. The experience of primary care informatics and informaticians can lead the way.

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