



## **Evidence Based Medicine, the Internet, and the Rise of Medical Informatics**

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Three quite separate phenomena - the emergence of medical informatics as a discipline in its own right, the move to a more evidence based clinical practice, and the rise of the Internet - may transform the face of modern medicine in the next century. The explosive growth of the Internet, a global phenomenon in its own right, may provide evidence based practice some of the key tools it needs to achieve its aims. Together they could combine to bring us the first generation of truly ubiquitous information tools into routine clinical practice.

With discussion of the Internet and the information super-highway filling the media, there is a feeling amongst many that information technology is coming of age. Within the medical community however, there is a dawning realisation that, despite the many promises of information technology, we may be lagging well behind other fields in its adoption (Coicra, 1996).

As with most things, these perceptions are ever only partially true. Information technology has not suddenly dramatically evolved. What has changed has been the level of its adoption by the public, and consequently the level of awareness of its potential amongst healthcare professionals. Equally, medicine has been no laggard in experimenting with new technology, and there is a long and rich history of informatics in clinical practice. For example, in the seventies and eighties much of the pioneering work in computer diagnosis focused on medical problem solving (Miller, 1994).

However, despite the considerable effort devoted to deploying information technology into the clinical workplace, it has for some time had little apparent impact on direct clinical care. This has led some to question whether information technology will ever have a significant role to play in clinical practice.

All this may now be about to change in a quite dramatic way. Three quite separate phenomena - the emergence of medical informatics as discipline in its own right, the move to a more evidence based clinical practice, and the rise of the Internet - may transform the face of modern medicine in the next century.

### ***Problems and technologies***

The field of medical informatics is concerned with the closely related problems of *information* and *communication* in healthcare. Indeed, the study of information underpins most of the business of medicine. It would thus be a mistake to see it as solely being concerned with the storage and retrieval of patient information. It covers everything from the manner in which evidence is used in clinical decisions, how one decides which piece of knowledge is relevant to a particular situation, and ultimately to how medical knowledge itself is created.

Studying communication alongside information allows us to understand the way in which information is exchanged between people. It explores the ways this can affect decisions, and how best to ensure that the process of communication is both efficient and effective. As healthcare becomes increasingly decentralised, with the burden of care shifting from hospitals to the community, these concerns become ever more critical. It is not just that patient data is being shipped in ever increasing quantities between hospitals and primary care practices. There is an increasing need to communicate the expertise we find in the hospital setting to the community physician who is making ever more complex clinical decisions.

Indeed, communication in all its aspects is increasingly being recognised as one of the main determinants of efficient health care delivery. For example, it is now clear that the healthcare system suffers enormous inefficiencies because of its poor communication infrastructure. One estimate suggests that the US health system could save \$30 billion per annum with improved telecommunications (Little, 1992).

The study of medical informatics should thus be a major part of medical practice, and information and communication technology should be common place and an invaluable component of it. How then do we explain the present gap between this potential and reality?

The first answer is that informatics in the seventies and early eighties did actually have a significant impact on clinical practice, but that this has gone largely unrecognised. People often think of information technology in terms of large computer systems and personal computers, but many of the early success stories look nothing like these.

CT scanners for example, revolutionised radiological investigation and were the computational forerunners of more modern methods like MRI and PET scanning. They were able to reconstruct digital images because they used advanced calculation techniques running on fast computer hardware. Equally, modern patient monitors are more computer than they are monitor. Much of their functionality comes from the hundreds of thousands of lines of computer code they contain. While automated arrhythmia analysis and ECG interpretation systems are now treated as commonplace, the research that contributed to their development challenged many early informatics investigators.

Despite these successes, much of the recent effort in moving information technology into mainstream clinical practice has been less than successful. This is not because clinical medicine has failed to attract the attention of information technologists. There have been countless experiments and prototypes of medical decision support systems, and many expensive and high profile attempts to develop electronic medical records. It is almost in spite of these continuing efforts, and despite some notable successes, that we are faced with the reality information systems are not commonplace in daily clinical practice.

In explaining this failure, we need to recognise that there are essentially two ways in which a technology can be applied to solve a problem. The first approach is *technology driven*. Here one asks "What problems will best be solved by using this new technology?" Inevitably, whatever the problem that is found, the answer will always be that this particular technology is the solution. This approach is often useful when trying to demonstrate the potential of a particular technological innovation. The second approach to the application of technological is *problem driven*, and asks the question "What is the best way to solve this particular problem?". In this approach, all kinds of solutions are explored, from changes in clinical process to the introduction of a new technology. Consequently, the answer to the problem may be that new technology is not always the best solution.

It should thus be fundamental that medical informatics is a problem driven discipline. It should first and foremost be concerned with understanding the nature of information and communication problems in healthcare. Only then should informatics try to identify if it is appropriate for technology to solve these problems and, if necessary, develop and apply these technologies.

Sadly however, it has often been the case with informatics in the recent past that most of the effort has gone into the technology, and problem definition has scarcely been addressed. One thus often finds informatics research that explores exotic technologies that solve problems that could be more easily solved with simpler existing technology, or indeed in non-technological ways. Equally as often, clinical information systems are designed in such a way that do not address the needs of the clinicians who will use them.

All this is about to change. The rise of evidence-based medicine now challenges clinical medicine to develop rational approaches to manage the ever rising tide of information and to convert it into shared best practice. Unsurprisingly there are

numerous cultural and technical problems associated with these challenges. Not least of these are those to do with the management and communication of information. Almost at the same moment that we are faced with these challenges, the Internet has emerged as an unexpected global phenomenon, offering unprecedented facilities for the creation, storage and communication of information. Is the Internet another example of a solution looking for a problem, or is it the best solution to our problems?

### ***Evidence Based Medicine***

For those who regard modern medicine as a rational and scientific endeavour, the contention that the efficacy of much medical practice is still not validated may come as a shock. The problem medicine faces is not that it lacks the will or the tools to evaluate treatments. The problem lies with the mechanisms that exist for transferring evidence into clinical practice, which are unable to keep up with the ever growing mountain of clinical trial data (Wyatt, 1991; Mulrow, 1994). For example, the first trial to show that streptokinase was useful in the treatment of myocardial infarction was published in 1959. Convincing evidence mounted in the early seventies, and the first multi-trial meta-analysis proving its value was published in the early eighties. However, formal advice that streptokinase was useful in the routine treatment of myocardial infarction only appeared in the late eighties (Antman et al. 1992). This was a full thirteen years after a close examination of the published literature would have indicated the treatment's value (Heathfield and Wyatt, 1993).

There are many other examples of similar delays in transferring research findings into routine clinical practice. The use of low dose anticoagulants in hip surgery, or inhaled steroids in the treatment of asthma both could have become routine treatments much earlier than they did. Just as there are barriers to research finding moving into clinical practice, it is just as hard for practitioners to access research findings. With well over a thousand journals publishing each week, practitioners with a particular clinical problem can struggle to find the best advice from the mountains of often contradictory research literature.

Following the pioneering work of Archie Cochrane who drew attention to the lack of systematic reviews of randomised controlled trials 20 years ago, the Cochrane collaboration is now perhaps the most influential organisation working in the area of evidence based practice (Goodlee, 1994). It was formed with the intent on creating and distributing evidence-based summaries of clinical best practice and its first database of systematic reviews, started by Archie Cochrane, covered Pregnancy and Childbirth research. The Collaboration, although still young, is now intent on creating systematic reviews of research for all areas of relevance in healthcare.

Unsurprisingly perhaps, given the nature of the problem, there has been a delay in the uptake of the Cochrane research digests in obstetrics (Patterson-Brown et al, 1993; Patterson-Brown et al, 1995). Thus, while evidence based medicine seeks to formally collate, assess and condense research findings, there still remains the problem of making the results easily available to practising clinicians.

### ***The Internet***

While it has been around for most of the 1980's, mostly as a global academic network, the Internet has only recently come into public consciousness. Essentially a network of networks, the Internet permits computers across the globe to communicate with each other.

At present, the Internet is in a phase of massive expansion, with growth rates of well above 10% per month. This is largely because, where before it's value for most people was marginal, it now offers communication and information services that surpass those possible by plain telephony or television. As more of these information services become available, even more people are being persuaded to join. It is the same phenomenon of technology adoption reaching a critical mass that we have seen in the past with other technologies like the telephone, the CD and the personal computer. When only a few people possessed them, there was insufficient market to develop the services and economies of scale that would make them mass market items. Once a certain threshold of ownership is exceeded however, the market develops rapidly. For a long time, users communicated on the Internet using electronic mail. This essentially allowed users to exchange text messages across the globe, usually in a matter of minutes. However, it was probably the advent of the World Wide Web that triggered the recent growth of the Internet. Essentially a set of software standards, Web programs allow users to navigate rapidly across the global Internet. Here they can view a bewildering variety of information, from the bizarre and inaccurate, to the most up-to-date information available from scientific bodies, newspapers and academic journals. For example, searching the Web for information on reproductive medicine, one can find material published by drug companies, academic units, and patient self-help groups.

There is now good evidence that such services are valuable and in constant use. The OncoLink information resource for example, provides oncologists with up to date trial and treatment information, as well as acting as an educational resource for cancer patients and their families. OncoLink was reportedly accessed 36,000 times in March 1994 (Buhle, 1994). The figure for November 1995 was 751,261 accesses.

Perhaps just as important as the ability to view information, the Web provides methods for anyone to publish information, and make it immediately available across the globe. This is achieved through a simple set of document standards that allow users to create electronic documents using text, image and video. The quality of these documents is now so high that the Web is used, for example, by several medical educational institutions. At the University of Iowa, for example, a set of teaching materials is assembled in their Virtual Hospital. The National Library of Medicine's 'Visible Human' project aims to create a complete, anatomically detailed, three-dimensional representations of the male and female human body and to make this available on the Internet. The project is collecting transverse CAT, MRI and cryosection images of male and female cadavers at one millimetre intervals.

### ***The Rise of Medical Informatics***

It is clear why many see the Internet as the vehicle of choice for the distribution of clinical practice guidelines. The match does seem made in heaven. Creating Web sites where up-to-date guidelines are stored, as the Cochrane Collaboration has already done, allows anyone connected to the Web immediate access to the guidelines. The rapidity with which changes can be incorporated into documents and made available to its readers seems like a godsend as medical scientists struggle to find publishing models that can cope with the speed of change in medical knowledge (Laporte, 1995). For the practising clinician, access to the Web will only become easier and cheaper over the next few years, as the market becomes increasingly commoditised. What makes this particular market so ripe for exploitation is that it is being fought over by

three separate industries, each today a giant in their own right. Telecommunications carriers, cable television companies, and personal computer companies know that the Internet has the potential to transform their existing businesses. Equally, if they do not gain control of it, it also has the potential to wipe much of their existing business out. For these players then, the next decade is a fraught time, but for the consumer, the rewards should be high.

As with all things however, there are potential drawbacks. Just as evidence based medicine might reap enormous rewards from using the Internet, there are forces at play that could, in theory, have exactly the opposite effect to the one intended. In particular, there are no formal controls on what can be published on the Internet, and indeed for many that is its great power. This means that while 'centres of excellence' like the Cochrane Collaboration will carefully vet any information they publish, others may publish any material they choose, with complete disregard to these standards of care. Thus the Web could, and in fact probably already is, contributing to the confusing growth in medical literature. Worse still, unlike academic journals where there is some sort of peer review process, there are no such checks for a would-be author on the Web.

This means that the medical profession has a number of important issues to deal with over the next few years. First it needs to be determined whether it is indeed physically possible to develop methods for sifting through the burgeoning medical literature and creating practice guidelines. There are many deep informatics issues here which are beyond the scope of this article (Coiera, 1995). Secondly, there is the issue of information distribution. While the Internet offers the means, it does not of itself provide the method. The equivalent of journal peer review mechanisms need to be established for material that is distributed across the Internet (Laporte, 1995). Equally, the medical profession must be made aware of these standards, understand how they work, and use them to assess any material they find on the Internet. This should also hold true to some extent for the public, who will also use the Internet as a source of health related material (Coiera, 1996).

### **Conclusion**

While it should not be taken for granted that technology can provide all the solutions to the problems being tackled by the evidence based medicine movement, it seems to have a genuine role to play. The explosive growth of the Internet, a global phenomenon in its own right, may well provide evidence based practice some of the key tools it needs to achieve its aims. Together they could combine together to bring us the first generation of truly ubiquitous information tools into routine clinical practice. And having made that critical first leap into the everyday routine of clinicians, medical informatics will become increasingly important. Indeed, in the next century it is more than likely that medical informatics will move from the highly technical and specialised field it is today, to become one of the central disciplines of clinical medicine.

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