# Opening Viewpoint

**Internet in Medicine: Information revolution in the support of healthcare provision – a historical perspective**

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*Introduction*: The improvement of human health and, as a consequence, the realisation of enhanced quality in human life, is one of the main aims of scientific endeavour in the field of medicine. The ultimate outcome of biomedical scientific research, and its implementation to clinical practice, is the effective provision of high-quality patient care. The use of technology has always benefited the medical field for achieving scientific breakthroughs in the diagnosis, therapeutic planning and intervention, prognosis and management of disease. Medical science, being an information intensive field where large volumes of experimental and clinically-related data are collected for the purposes of interpreting the effect of disease in humans, has been transformed from the recent developments of Information and Communication (ICT) technologies. Over the past 15 years, the era of Internet-based communications, networked-enabled capabilities have allowed open access to healthcare information and distributed informatics tools for the provision of care to the point-of-need, i.e. the patient [1].

The concept of global networking started with the ARPAnet experimentation [2], limited to research labs on selected US Universities, and has been further established by the evolutionary creation of a network of networks, i.e. the modern Internet, with its associated information access technologies, such as the World-Wide-Web (WWW). The latter, being created as "a pool of human knowledge" [3] has facilitated the broad adoption of Internet-based technologies in order to support electronic communication, collaboration and social interaction among the general public. The benefits of the Internet to scientific community are equally astonishing, allowing academics, scientists and researchers to achieve an open information and knowledge sharing. The Internet in Medicine [4], which started merely as an academic curiosity, became an important area of interest for health professionals and researchers. "Like the stethoscope or coat-pocket handbook, the Internet is a tool that promises to extend our experience and complement existing abilities to learn and practice medicine" [5].

This short paper will provide an overview of the important milestones in the development and evolution of the use of the Internet in the field of medicine. In our discussion, we take a historical standpoint on the scientific work reported in the series of MEDNET World Congresses and the efforts of the Society for the Internet in Medicine, over the past 10 years.

*The Internet in Medicine Scientific Community* – the early steps: The **Society for the Internet in Medicine** (SIM) [6] was launched in October 1996 at MEDNET 96 – The European Congress of the Internet in Medicine. It came into being as a result of developments in the area of the Internet in Medicine that had taken place at the Royal Sussex County Hospital (RSCH), Brighton, UK [7]. In December 1994, information regarding RSCH was placed on the World-Wide-Web, which at the time was a novel concept, resulting in much interest from the medical community around the UK and beyond. Subsequently, a one day meeting entitled **Towards an Information Superhighway in Medicine** was held in July 1995 at the

University of Sussex [8], Brighton, UK, under the auspices of the Trafford Centre for Graduate Medical Education and Research [9]. The success of this meeting prompted individuals from the Sussex area to organise MEDNET 96 [10] at the Brighton Conference Centre, which was attended by an international body of delegates. An open business meeting was held at MEDNET 96 to discuss how the project should be taken forward, and as a result SIM was created. SIM's initial remit was to ensure that a further conference on the Internet in Medicine was held and that the promotion of scientific medical education and access to quality information through the Internet is safeguarded by appropriate scientific efforts and clinical implementation. SIM, being an open scientific society, now has members from all over the world and is successfully organising the MEDNET series of Congresses, this year being the 10th Anniversary from the original one. In addition to this, SIM is continuously supporting scientific dissemination of research in the field of Internet in Medicine, through its official scientific journal, the *Journal of Medical Internet Research* [11]. SIM and MENDET have been influential in the development of the field, and together with other international healthcare/medical informatics bodies and events, have advanced the scientific area of **Internet in Medicine**, from both a research and clinical applications perspective.

The MEDNET congress series have evolved from the initial research curiosity of generic medical applications of the Internet in Medicine (with a bias towards telemedicine and tele-radiology) to the development of concrete research and clinical implementation outcomes on aspects of the application of Internet in the access of information for the consumer and associated legal/ethical issues, the development of distributed clinical information systems, the progress towards an integrated electronic patient record, the support of evidence-based practice, the deployment of robust global and regional health information networks, the role of the internet in the developing world, the study of quality assurance procedures for healthcare internet-based information, the facilitation of e-learning and continuing medical education, the support of medical research and distributed network-enabled clinical trials, and the impact of the Internet in Public Health. The outputs of this research and their appropriate clinical implementation are numerous and have grown to what we currently term as provision of e-health [11]. "E-Health is an all-encompassing term for the combined use in the health sector of electronic information and communication technology (ICT) for clinical, educational, research and administrative purposes, both at the local site and at a distance." [12].

To review all the above-mentioned research advances over the past 10 years will be futile and beyond the scope of this paper. In the following paragraphs we will try to set the scene for most of these achievements and provide exceptional examples of success in the clinical implementation of network-enabled technologies for the provision of patient care.

*Medical Applications*: From the early years of MEDNET, the community was preoccupied with the implementation of particular applications of the Internet in the advancement of specific medical field [10, 13]. Visualisation and imaging and their implementation to telemedicine and Telecare have been the dominant examples of early work. Novel medical visualisation of human anatomical structure has been rapidly realised since the completion of the Human Visible Project [14]. The rich anatomical data sets have been made available through the Internet. The data have acquired to serve as "a common reference point for the study of human anatomy, as a set of common public-domain data for testing medical imaging algorithms, and as a testbed and model for the construction of image libraries that can be accessed through networks." [15].

A variety of applications for tele-radiology have been tested with the availability of the Human Visible Project Data, while the most notable applications in clinical practice have been the introduction of the concept of virtual endoscopy (for local and network-enabled visualisation) and the use of image-enhanced surgical planning to support remote surgery over the Internet. In particular, virtual endoscopy [16–18],

is one of the earlier endeavours in biomedical virtual reality and internet-based research. It is now becoming a clinically acceptable new form of non-invasive screening for the diagnosis of structural abnormalities in internal organs [19]. The literature contains a vast amount of work that successfully report the clinical implementation and use of virtual endocscopy in the organs of the colon [20], small bowel [21], stomach [22], tracheo-bronchial tree [23], and so on and its relation to the Internet [24–26].

Surgical planning, simulation and remote surgery applications have also been reported as initial research ideas [27]. The research and the visions put forward have recently become a reality, with a successful completion of a transatlantic robot-assisted surgical intervention over the Internet; On September 7, 2001 surgeons in New York performed a laparoscopic cholecystectomy on a patient in France [28]. A variety of other clinical applications for Internet-based cardiology studies, chemotherapy planning and support, tele-pathlogy, etc., have been reported over the first years of the MEDNET conferences [10,13,29,30].

In addition to the above applications, the Internet has been essential in the provision of e-learning for medical education. "The ubiquitous and multimedia nature of the Web environment has already made a significant impact on medical education. In addition to facilitating the creation and distribution of innovative educational content, it creates a virtual arena for instant global communication and collaboration" [31].

*Evidence-based practice*: The role of the Internet has been catalytic in the advancement of evidence-based practice [29]. The distributed tools available through the network have facilitated the generation, synthesis, dissemination and exchange of research evidence throughout the healthcare community. Since the early efforts of medical librarians to create electronic databases of medical content (e.g. [32], and medical libraries sessions of [10,13,29]) with appropriate database structures, indexing and organisation, we have now reached the construction and dissemination of important projects over the Internet in the support of evidence-based practice. The Cochrane Collaboration [33] is an example of an Internet-based resource, at an International level, providing guidelines, tools, training materials and systematic reviews of current medical literature, in order to ensure the accessibility of quality healthcare information for the practice of evidence-based decision in the everyday clinical work of healthcare professionals. Furthermore, such facilities, together with specific research efforts that ensure the quality of general healthcare information available to patients (see Health-on-the-Net Foundation effort [34]), have assured the quality of consumer-based information and, therefore have managed to implement appropriate levels of trust in the available medical knowledge over the Internet [35–38]. The effort to keep the consumer and the general public informed can be also identified in initiatives such as the MEDLINEplus and the ClinicalTrials.gov from the National Library of Medicine [39], where patients and professionals can have a transparent access to information relating to clinical research and how it affects individuals.

Since the early years of MEDNET Congresses, there has always been a great interest in bridging the gap between the developed and the developing world [40]. The attempt in providing accesses to high-quality information to developing countries has been assisted by the creation of global and regional information networks. However, there are many challenges ahead.

*Concluding Remarks*: Our brief historical exploration of the Internet applications in medical research and clinical practice has shown that the impact of the technology can be characterised as "**ground-breaking**" and "**revolutionary**" in the context of enhancing the quality of patient care. The informatics tools that Internet has offered to the medical field are now widely accepted and validated for everyday use in clinical practice. The Society for the Internet in Medicine and the MEDNET World Congress series have been instrumental in this endeavour. The outputs of this venture shows that the Internet has still the potential to offer a real value to further improve the appliance of informatics in healthcare and, as a consequence the quality of human life.

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