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OpenClinical.net: A platform for creating and sharing knowledge and promoting best practice in healthcare☆

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ABSTRACT

It is well known that medical knowledge is growing so rapidly that it is difficult or impossible for healthcare professionals to keep up. More and more techniques for diagnosing and treating diseases are becoming available, yet new research findings and clinical practices are slow to spread. Information technology and the internet are providing important new ways of disseminating knowledge in healthcare as in many other domains. Knowledge engineering techniques for supporting decision-making and process management are also becoming available, and can be used to support busy clinicians, helping to ensure that their decisions are consistent with current knowledge and clinical procedures are carried out in a timely, efficient and safe way. The OpenClinical.net project is building on these techniques to demonstrate a new paradigm for disseminating knowledge and promoting best practice. The key idea is that much professional expertise can be modelled as computer-interpretable knowledge and used to assist decision-making, workflow management, communication and coordination of care and many other professional tasks. The central goal of OpenClinical.net is to demonstrate how this might be done at scale, through a form of "crowd sourcing", in order to create and maintain a sharable knowledge base that is available in an open access and open source repository. This paper provides an overview of the project and a summary of progress to date.

1. Introduction and background

> *"Imagine the stimulus that a well-researched, evidence-based repository of standardized medical knowledge, with tools for delivering patient-specific advice at the time of need, would have on the ability to deliver computerised decision support services" – Robert A. Greenes (Ed.), Clinical Decision Support: The Road Ahead, Academic Press, New York, 2007.*

Medicine is facing a "knowledge crisis", in that knowledge is expanding explosively but limited economic resources restrict our ability to disseminate new practices, and finite human capacities limit our ability to absorb and use new knowledge well. To address this many healthcare organisations around the world develop and maintain *clinical practice guidelines (CPGs)*. These are intended to promote high standards of care in specific areas of medicine by summarising best clinical practice based on careful reviews of current research. Individual hospitals and healthcare providers often maintain collections of local guidelines that are adapted from national or international CPGs to accommodate local policies and circumstances. Unfortunately busy clinicians frequently have little time to read and absorb lengthy documents, and the guidelines may also be difficult to access, use and keep up to date. The practical effect is that CPGs do not have the anticipated benefits in terms of improvements in consistency, quality and safety of patient care.

The OpenClinical.net knowledge sharing project provides a comprehensive suite of software for designing, implementing, documenting and deploying decision support, workflow and other applications (Fig. 1). This paper provides an overview of the project

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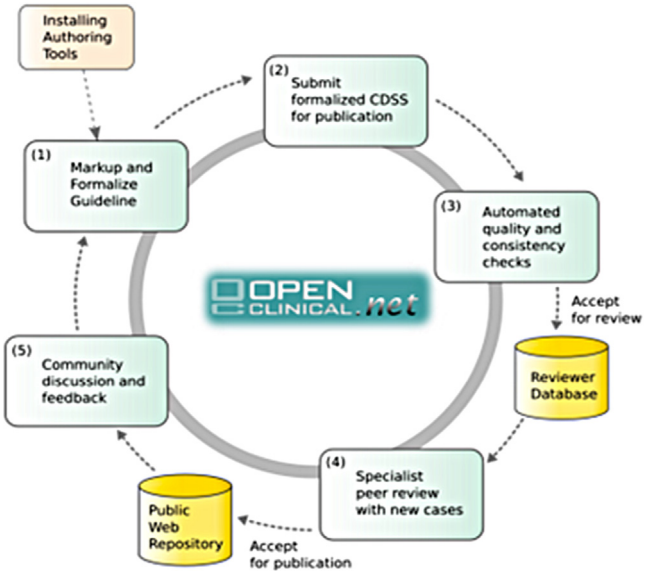

Fig. 1. The OpenClinical.net development lifecycle.

and summarises the main components of the suite for this special issue as an example of an "innovative application of emerging information technologies that deals with the collection, storage, retrieval, sharing, and use of health data and knowledge for communication and decision-making". It is a bird's eye view of the project, neither a scientific paper nor a detailed technical description of the technology platform, which can be found elsewhere (e.g. [1,2]). Its purpose is to introduce the OpenClinical.net concept, explain its current status and what it can offer, and provide potential users, partners and sponsors with information to assess whether it may have value to them for achieving their own objectives.

1.1. Project history

The OpenClinical project was established in 2001[2] to raise awareness and promote the adoption of decision support, workflow management and other knowledge based services in clinical practice (www.openclinical.org). The original information service and web portal was under continuous development until 2011 when it had about 600 pages of material[3] covering technical, clinical, policy and other aspects of the field, and provided many links to other projects, demonstrations and prototypes. The site was widely used for reference and teaching and at peak was receiving more than 350,000 visitors a year[4] but the growing interest in clinical decision support and other knowledge-based services and the dramatic growth of the eHealth industry over the last decade has meant that it has become difficult to keep the content up to date. However, the project has achieved its main objectives of raising awareness and we are now building on the success of the first phase by reconfiguring it in a radically new form.

OpenClinical.net (www.openclinical.net) was established in 2005. Its overall mission is the same but the methods are very different. It was seen from the outset as offering *practical tools* for formalising and disseminating medical knowledge in a *computer interpretable form*, as opposed to the traditional current awareness services provided by OpenClinical.org. The technical platform is based on two innovations: a decision and process modelling language (PRO*forma*; [3,4]), and an application development and deployment platform (*Tallis*, see http://www.cossac.org/tallis and http://archive.cossac.org/tallis/Getting_started.htm).

1.2. Overview of the paper

In the next section we introduce *Repertoire*, an open access and open source knowledge repository, for knowledge sharing. We then outline the knowledge engineering methodology and content management lifecycle that has been adopted for the first release of OpenClinical.net. The process of designing, uploading and deploying a clinical pathway and decision support service on *Repertoire* is illustrated in Section 3 by means of an application that guides the diagnosis and management of patients with an acute head injury. This is based on standard practice in UK hospitals and can be accessed at http://www.openclinical.net/demos/head-injury-uk.html. A key challenge for any novel medical technology is that it should be based on clear principles, and a brief summary of the formal basis of the OpenClinical approach to decision-making and process management is provided in Section 4, with references to detailed publications about the underlying theory and evidence for effectiveness. The paper closes with some remarks about the "business model" that we are developing to make OpenClinical.net sustainable and the governance principles we have adopted. There is a glossary of terms at the end of the paper.

2. Towards an open access, open source repository of medical knowledge

It has been recognised for many years that information burdens and other pressures on healthcare professionals are leading to significant levels of suboptimal patient care, with unacceptable levels of medical error and wasteful use of resources (e.g. *To Err is Human*, [5]). The medical informatics community has sought to find ways of addressing this by formalising clinical guidelines and other kinds of medical knowledge in machine interpretable, sharable and interoperable formats as a foundation for IT services that support quality and safety of care (e.g. [6]).

Traditional clinical guidelines commonly take the form of *text documents* and/or *process diagrams*. These can be read and understood by people but cannot as yet be interpreted by a computer. Peleg et al. [6] compare a number of different formats that have been developed for modelling clinical guidelines in a computer executable format. One of the languages reviewed in Peleg et al.'s paper is PRO*forma*; this is outlined below but is described in detail by Fox and Das [3] and has been published as an open standard [4]. From an application developer's point of view the availability of a standard guideline modelling language and tools for delivering applications have made it possible to develop a comprehensive development platform that has sufficient capabilities and tools to allow clinicians and researchers to design, implement, deploy and evaluate PRO*forma* services in many fields of healthcare. OpenClinical.net is intended to promote and assist good practice in any field of specialist medicine and healthcare, allowing individuals, professional bodies, care providers and other organisations to share their expertise in the form of decision support and other computer services.

The OpenClinical.net development platform and web publishing infrastructure are operational; members of OpenClinical.net can download a process modelling tool (*Tallis* composer) and use it to create PRO*forma* models that can be enacted by server-side software (the *Tallis* workflow and decision engine) and rendered as web pages with an enactment tool called *Solo*. *Solo* provides a

[2] Established by J. Fox and R. Thomson, funded by Cancer Research UK.
[3] Thanks largely to the sustained efforts of Richard Thomson, the managing editor of OpenClinical.org.
[4] Mostly from the English-speaking world including 50% from the USA.