Integrating clinical decision support and smart guidelines: a new approach to evidence based medicine

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The modern clinical environment is increasingly demanding, requiring a wealth of detailed knowledge across multiple specialties, quick and safe decision-making on many different topics, reliable communication between all the stakeholders, and more and more documentation. In addition there is the problem of keeping up with changes in practice and policy; with new research published every week health and social care teams have their work cut out if they are to make the right decision every time throughout the journey of patients with serious conditions.

The movement for evidence based medicine is trying to mitigate this problem by maintaining up-to-date clinical guidance on the best treatments for specific medical conditions based on systematic reviews of current research. Despite the huge international effort that goes into preparing and maintaining clinical guidelines for pretty well the whole of medicine (see The National Guideline Clearing House[1]) which are underpinned by authoritative reviews (e.g. The Cochrane collaboration[2]) there appears to be surprisingly limited return on this investment in terms of compliance with guidelines[3]. Among the many difficulties are a lack of time for doctors to keep up with new developments of course, and even if they have access to good quality guidelines it is hard to reliably commit their contents to memory. Furthermore, guidelines may be only infrequently updated and there may be several guidelines that deal with similar conditions in different ways. A final key issue is that general guidelines provide general advice and cannot accommodate the diverse personal and social circumstances of the patient, multiple co-morbidities, individual preferences and so on.

COSSAC[4] is a collaboration between engineers and scientists at Oxford University and clinicians at London's University College and Royal Free Hospital. The group has a longstanding research programme aimed at understanding the complexities of practical decision-making, and clinical expertise in particular. The group's aim is also to provide a secure foundation for designing "decision support systems" that can deliver suggestions for care to healthcare professionals quickly, accurately and in an intuitive and natural way. Out of this research has come a versatile software platform called CREDO which has been shown to provide excellent support for clinical decision making in a wide range of situations, from primary to specialist and multidisciplinary care. CREDO can help to help with risk assessment and referral decisions, patient triage, choice of tests and investigations, diagnosis, treatment and follow-up decisions. Individual healthcare professionals such as GPs and home care workers or multidisciplinary teams can use CREDO to record data about a patient and call up individualised recommendations. CREDO can also present the rationale and supporting evidence for the clinician to consider and/or discuss with the patient.

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[1] www.guideline.gov

[2] www.thecochranelibrary.com/view/0/index.html

[3] See for example Fox et al, From clinical guidelines to decision support: closing the loop" *J Roy Soc Med*, 2009.

[4] The COSSAC team includes Ioannis Chronakis MD, Vivek Patkar MRCS, Prof. John Fox PhD, David Glasspool PhD and Matt South PhD. This article has been prepared by john Fox.

A major CREDO application is focused on multidisciplinary care of cancer patients and integrated care pathways (see YouTube video at www.youtube.com/watch?v=zoxpuzH4B_0). The project has recently reported very promising results from a study with Mr. Mo Keshtgar and the breast cancer team at the Royal Free Hospital. Figure1 shows this system "MATE" in routine use in the weekly team meeting. A recent paper in *BMJ Open* describes how MATE can significantly improve compliance with NICE and other high quality guidelines and have a major impact on identifying patients who are eligible for recruitment into clinical trials. The system is well liked by the breast team and has revolutionised the way they record patient information. All data are quickly captured in a structured format that facilitates concurrent and retrospective quality and safety audits, and ongoing clinical research. Oxford University and University College London are now collaborating on developing similar applications for other common cancers and multidisciplinary care pathways.

Figure 1: A view of a routine multidisciplinary meeting of the breast cancer team at the Royal Free Hospital in London. The MATE decision support application is projected on the screen at the front of the room, alongside the usual breast imaging and pathology information. Thanks to Mr. Mo Keshtgar for leading the MATE trial and permission to use this photograph.

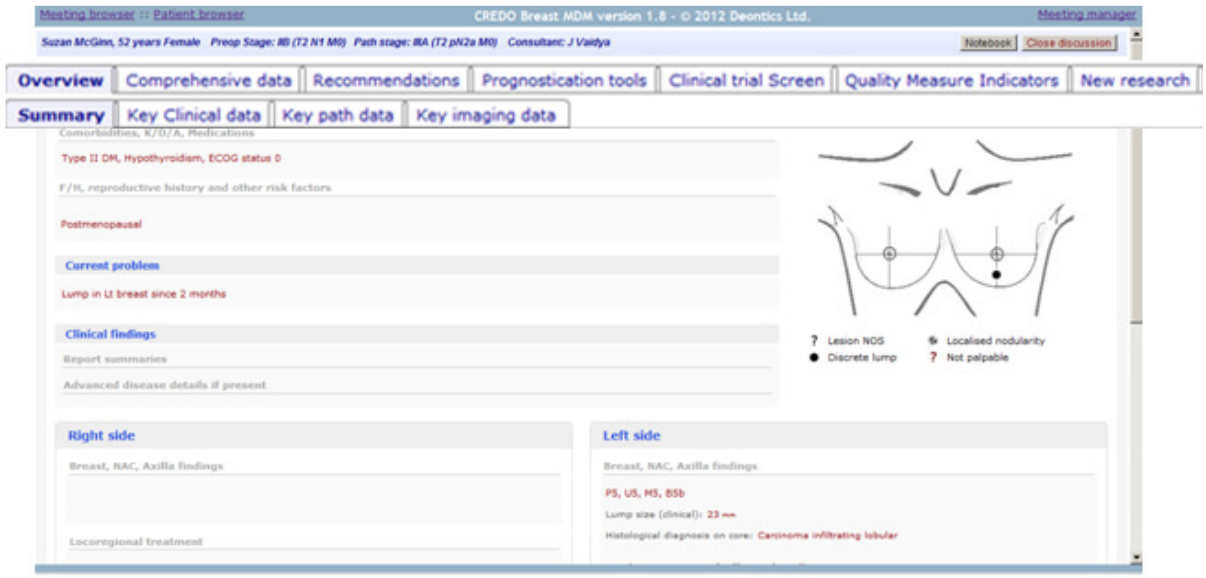

Figure 2: Patient summary screen of CREDO MDM, a web version of MATE for breast cancer. Tabs at the top provide access to the patient database, guideline based recommendations and prognostications for the patient and other decision support services.

The key factor in the success of the COSSAC approach to clinical decision support was the development of a naturalistic model of decision making and clinical processes, captured in a powerful and versatile modelling language called PRO*forma*[5]. The language has been used to build many operational applications, from simple "apps" such as the patient triaging service provided by NHS Direct in the UK[6] to guideline based decision support tools for GPs which have been rolled out in New Zealand[7] as well as sophisticated applications for specialist and multidisciplinary cancer care.

The team have now developed a new generation of tools for creating and deploying CREDO-style decision support functions which are integrated with conventional guidelines in a novel way. Figure 3 shows an application for the diagnosis and treatment of thyroid nodules, which has been developed in collaboration with the University of Haifa[8] and AACE[6]. The system shows how a conventional guideline can be enhanced with many evidence-based functions, including workflow and decision making support. The hybrid arrangement shown in figure 3 combines the familiarity and other benefits of the traditional guideline document with the speed, versatility and consistency of a decision engine. The contents of the two presentations are linked together in that electronic records and decision support services can be invoked from within the guideline at any time, and relevant sections of the guideline and supporting evidence can be displayed as part of the rationale for any recommendations for diagnosis and treatment that the system suggests.

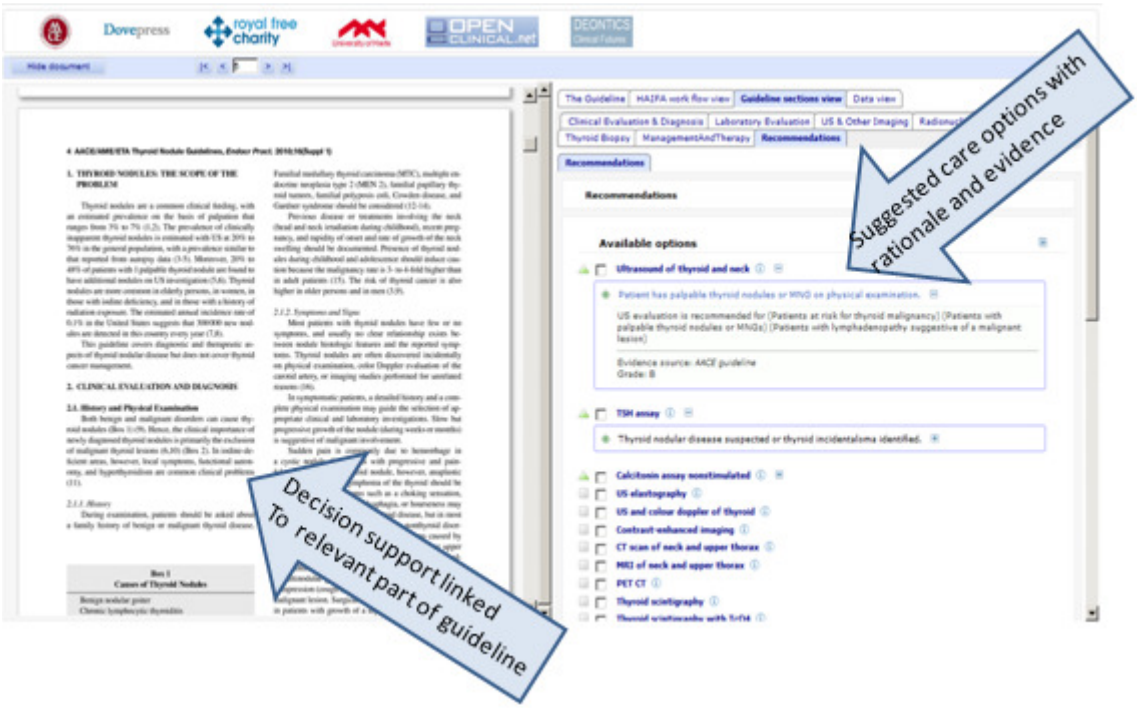

Figure 3: Integration of conventional clinical guideline (left) with CREDO services developed using the PRO*forma* knowledge representation language (right). After a basic history and physical have been completed the CREDO system suggests care options (here investigations). Thanks to AACE, Dove Medical Press, Royal Free Hospital Charity and Deontics Ltd. for supporting this project and permission to publish this screen shot.

[5] An overview of the PROforma language is at www.openclinical.org/gmm_proforma.htm
[6] http://www.nhsdirect.nhs.uk/checksymptoms developed by *Infer*Med Ltd. for the UK National Health Service
[7] http://www.bpac.org.nz/magazine/2009/july/asthma.asp developed for Best Practice Advocacy Centre in New Zealand by InferMed Ltd
[8] Developed by Deontics Ltd. for the American Association of Clinical Endocrinologists, the Royal Free Hospital Charity and Dove Medical Press Ltd

Clinical decision support systems are a key tool for extracting value from the electronic medical record systems that are being increasingly deployed all over the world. In fact it can be argued that electronic records alone may simply add to the information burdens and demands for documentation that clinicians hate, and that the potential value of excellent records is only released when additional services like clinical reminders and alerts, order entry, electronic prescribing and so on are built into the systems. It is now being recognised that advanced decision support systems also offer a further important opportunity to add value to clinical guidelines by delivering the potential of evidence-based medicine to improve outcomes and the quality and safety of care, which guidelines by themselves do not.

Biography of first author

John Fox originally trained as a cognitive scientist and has research interests in artificial intelligence and computer science and their application to medical decision making, with a practical focus on developed advanced clinical decision support tools. His early career was in the USA after which he joined the UK Medical Research Council and later moved to Cancer Research UK to establish an interdisciplinary research programme in medical computer science and clinical informatics. At CRUK he and his colleagues developed a number of novel technologies which have been successfully deployed. A key milestone was the creation of the PROforma language for formalizing clinical decisions and processes of care, which attracted the 20th Anniversary gold medal (Laureate Prize) of the European Federation of Medical Informatics. PROforma is arguably the most sophisticated open standard for modeling clinical guidelines and care pathways currently available. The background and motivation, conceptual foundations and technical details of PROforma are described in Safe and Sound: Artificial Intelligence in Hazardous Applications *(Fox and Das, MIT Press, 2000). In 2007John moved to Oxford University as a Professor of Engineering Science, but he also spends a large part of his time working on clinical projects at the Royal Free Hospital and UCL Cancer Institute in London. He is married, and lives with his wife Helen and two sons Gilon and Marcus in Leamington Spa, Warwickshire.*