Editorial

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Biographical notes: Raouf N.G. Naguib is Professor of Biomedical Computing and Head of BIOCORE. Prior to this appointment, he was a Lecturer at Newcastle University, UK. He has published over 290 journal and conference papers and reports in many aspects of biomedical and digital signal processing, image processing, AI and evolutionary computation in cancer research. He was awarded the Fulbright Cancer Fellowship in 1995–1996 when he carried out research at the University of Hawaii in Mānoa, on the applications of artificial neural networks in breast cancer diagnosis and prognosis. He is a member of several national and international research committees and boards.

Azzam F.G. Taktak is a Consultant Clinical Scientist at the Royal Liverpool University Hospital and an Honorary Lecturer at the University of Liverpool. He has a BEng Degree with Honours in Electronic and Electrical Engineering and a PhD in Biomedical Engineering both from the University of Salford, UK. His main research interests are mathematical modelling and the use of artificial intelligence and machine learning in medicine especially in cancer. To date he has published more than 50 peer-reviewed papers and edited a book on outcome prediction in cancer. He has recently led a European project on ocular oncology under the Biopattern Network of Excellence which was funded by the European Commission.

Decision Support Systems (DSSs) play an important role in healthcare by assisting clinical and healthcare personnel in delivering their services in a more methodical and efficient manner. This is usually achieved through the analysis of patient-specific clinical variables. Many of these systems are used to enhance diagnostic efforts. Other forms of clinical DSSs seek to prevent medical errors and improve patient safety. A number of potential benefits accrued from the use of DSSs in medicine have been widely reported in the literature. As described above, these mainly fall into three broad categories:

- improved quality of care
- improved patient safety
- improved efficiency in healthcare delivery.

DSSs used in a medical and/or clinical context vary greatly in their complexity, function and application. These clinical tools differ from practice guidelines and clinical pathways in that they require the input of patient-specific clinical variables and, as a result, provide patient-specific recommendations. Guidelines and pathways, in contrast, may not require the input of such information and provide more general suggestions for care and treatment. Although many clinical decision support systems are now computer-based, some are relatively simple, with no inherently complex internal logic systems. More complex systems include computerised diagnostic tools that, although labour intensive and requiring extensive patient-specific data entry, may be useful as an additional and assistive measure when a patient presents with confusing symptoms and an unclear diagnosis. Other systems, both simple and complex, may be integrated into the point-of-care and provide accessible reminders to clinicians regarding appropriate management based on previously entered data. These systems may be most practical when coupled with computerised physician order entry and electronic medical records. Finally, through their integration with practice guidelines and critical pathways, DSSs may provide physicians with suggestions for appropriate care, thus decreasing the likelihood of medical errors (Trowbridge and Weingarten, 2001).

Integrating medical knowledge and advances into the clinical setting is often difficult due to the complexity of the involved algorithms and protocols. Similarly, the process from innovation to routine clinical use of a DSS is often long and complex. Many systems fail to reach the clinical environment for a number of reasons. Some systems for example might be highly theoretical with little relevance to the real world. Others might have been technology-driven. In order for such systems to be integrated into routine settings however, thorough scientific and clinical evaluation must be undertaken in controlled trials.

Johnston et al. (1994) conducted a comprehensive survey of over 800 DSSs. The study concluded that there was strong evidence that DSSs can improve physicians' performance. However, there was not enough evidence regarding improvement to patient outcome and cost-effectiveness. A more recent study reviewed 100 evaluation studies of DSS in controlled trials (Garg et al., 2005). Once again, the study concluded that whilst there was sufficient evidence that these systems benefited the practitioner, there was still little evidence of improvement of patient outcome.

In this special issue, a range of topics covering different aspects of DSSs are included. On the Signal Processing side, Last et al. present a multi-component system for improving beat detection in ECG analysis using linear and non-linear models. Martini et al. describe a real-time system for artefact removal in ECG signals using adaptive filters. Mendez et al. describe an automated system for sleep staging. These papers are good examples where DSSs can play an important role in automating tasks thus enabling clinicians to spend more time in enhancing their clinical decisions. On the Disease Management side, Ansermino et al. review the state-of-the-art in intelligent monitoring systems in anaesthesia and other areas of physiological measurement. Sfakianakis et al. review current trends in data integration in the genomic sciences. On the Diagnosis side, Gan Lim et al. describe a system for aiding clinicians

in processing images with suspected colorectal cancers using self-organising maps and textural properties of these images. Plumley et al. describe the development of an image description language system to aid in the reporting of observed features in cancer imaging. On the Prognosis/Risk Stratification side, Ardoino et al. describe a system for evaluating response to treatment in myeloid leukaemia, whilst Doulaverakis et al. describe a system for the classification of risk for cardiovascular diseases. These systems play an important role in helping clinicians and other healthcare professionals in targeting the appropriate individuals who would benefit most from screening programs and regular follow-ups after treatment. Finally, a paper by Price and Summers describes the importance of various ontology schemes in the implementation of DSSs in healthcare. This is a very important topic as many countries in Europe and the USA are investing large amounts of money and effort into these schemes.

References

Garg, A.X., Adhikari, N.K.J., McDonald, H., Rosas-Arellano, M.P., Devereaux, P.J., Beyene, J., Sam, J. and Haynes, R.B. (2005) 'Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review', *JAMA*, Vol. 293, No. 10, pp.1223–1238.

Johnston, M.E., Langton, K.B., Haynes, B. and Mathieu, A. (1994) 'Effects of computer-based clinical decision support systems on clinician performance and patient outcome: a critical appraisal of research', *Annals of Internal Medicine*, Vol. 120, No. 2, pp.135–142.

Trowbridge, R. and Weingarten, S. (2001) 'Clinical decisionsupport systems', in Shojania, K., Duncan, B., McDonald, K. and Wachter, R. (Eds.): *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*, Evidence Report/Technology Assessment Number 43, AHRQ Publication No. 01-E058, AHRQ, Rockville, MD.