Patient safety is increasingly recognized as a vital issue for health care [1], and enhancing the use of information technology represents an important way to reduce clinical errors [2–4]. We still have much to learn about what technologies and methodologies will result in the greatest differences, how we might apply them most effectively, and how evaluators can assess their contributions to overall patient safety.

This special issue of the Journal of Biomedical Informatics (JBI) focuses on two key themes that are central to patient safety research: how cognitive factors affect performance, and how informatics methods can identify sources of errors and provide interventions that reduce them. Cognitive factors have a decisive impact on whether information technology has a positive influence on human performance [5]. Cognitive science and studies of medical cognition can meaningfully inform and shape design, development, and assessment of information systems and decision-support technology. Nonetheless, these techniques tend not to be used effectively in software design and development. It is time to recognize that cognitive factors are especially important in understanding and promoting safe practices. Cognition is accordingly an important area of emphasis in this special issue.

Among the 10 original research papers in this issue, five explore issues related to cognitive factors [6–10]. User interfaces have long been recognized as important elements in devices, as poor interfaces can increase the likelihood of error. In the first paper, which evaluates a computer-based physician order entry system—a technology with one of the best track records for improving safety—Horsky et al. [6] use a distributed resources approach to address issues of cognitive complexity. They find that the configuration of resources places unnecessarily heavy cognitive demands on the user. System redesign with considerations of such concerns may result in higher levels of user performance. In the next paper, Zhang et al. [7] employ heuristic evaluation—a technique commonly applied in software evaluation—to characterize the usability of two infusion pumps that can be sources of clinical error. This low cost approach (analyzing safety violations) identified important safety-related differences between the pumps. In the third paper, Keselman et al. [8] also address infusion devices, but at the level of decision-making regarding equipment purchases by institutional staff. Their most important finding is that administrators (who are the decision-makers) value safety but appear to equate it with technical accuracy alone rather than weighing human factors issues—which may be more safety-critical.

The next two cognitive studies break important new ground. In the future, extending health-related information technology to patients' homes will undoubtedly become more important, especially in the management of chronic diseases. Kaufman et al. [9] evaluate a home telemedicine technology, employing a video-analytic field usability methodology. They find important problems with the interface that may make it difficult for patients to perform specific tasks. These patients may also lack the prerequisite competencies for productive use of e-health resources.

Investigators have often compared cognitive differences between specialists and generalists, with studies identifying better performance by specialists for problems within their domain [10]. Hashem et al. [11] show, however, that there is a downside to experts' behaviors. Specialists tend to diagnose cases from outside their domain as though they fall within their areas of expertise, often assigning higher probabilities to diagnoses that are familiar to them than do clinicians who are expert in other areas. This study is also of interest because it explores diagnostic errors in the context of patient safety, a perspective that needs more attention in both safety and informatics research.

The second set of five papers deals with implementations of information technology and their role in measuring errors or promoting patient safety. The first two studies address development and refinement of applications for improving safety, with one targeting allergies [12], and the other addressing abnormal test results [13]. Kuperman et al. [12] discuss the superficially simple problem of identifying allergies and warning physicians when a patient has a known allergy to a drug that is about to be ordered. In fact, there are many complexities, including creating groups of allergies and medications, deciding which allergies to display, developing strategies to capture allergies, and developing warnings that increase the likelihood that users will respond appropriately to the most urgent alerts. The last
two aspects are particularly important and require taking into account human factors techniques. Poon et al. [13] present an application designed to help providers to deal with an important patient safety problem: ensuring that they manage test results well. This application was designed to address workflow issues, to bring key knowledge to the point of care, and to make it easier for clinicians to identify and risk-stratify the results according to degree of abnormality.

One of the most troublesome issues in patient safety research has been deciding how to measure safety. Adverse events occur rarely, and have been hard to detect. Errors are much more frequent, but most do not result in adverse events. Computer-based approaches for detecting adverse events hold substantial promise, although the positive predictive value of alerts from such software has typically been low [14]. In the next paper, Hope et al. [15] compare a tiered approach (using layers of personnel of varying degrees of expertise) with traditional pharmacist review for determining whether computer-based data about a patient represent an adverse drug event. They find the tiered approach to be more cost-effective. In the next study, Cao et al. [16] explore an innovative approach for using keyword searches to detect errors in discharge summaries. Although the sensitivity of this approach is very low, so is the cost of identifying problems using this strategy. The authors target a broad range of errors; most prior evaluations have focused on a specific domain such as adverse drug events. Finally, Weinger et al. [17] define a non-routine event as one that deviates from optimal patient care. They introduce a novel methodological approach for detecting non-routine events and demonstrate the efficacy of these analytical methods in the context of surveying anesthesia providers.

We close with two methodological review papers, in keeping with the JBI tradition of publishing one review in each issue of the journal. In the first paper, Hripcsak et al. [18] describe an iterative approach to event discovery in electronic medical records that is based upon the application of natural language processing techniques. The framework described includes: (a) targeting specific events, (b) defining methods for analyzing a subset of information from a data repository, (c) using NLP methods to parse and code the narrative data, and (d) generating queries to detect and classify errors. The authors conclude that electronic detection of medical events appears to be an important and feasible avenue of patient safety research.

Finally, Murff et al. [19] review the broad range of methodologies for detecting adverse events, and suggest that computer-based detection approaches are likely to replace spontaneous reporting, although these approaches work better for adverse events than for errors or near-misses. Furthermore, such approaches are not likely to become widely used without regulation requiring organizations to invest in these technologies [20]. The review also considers a cognitive framework for error-related research that can provide insight into the process of error generation. This type of research will not only aid in error detection, but also inform evaluation and intervention strategies. The study of computer-based detection of adverse events and errors, informed by cognitive research, represents a high priority area for further research.

Berwick [21] has discussed achieving a 100-fold improvement in patient safety. If we are to come close to achieving that goal, a key will be to increase the judicious use of information technology in healthcare. Developers of such information technology will need to consider human and cognitive factors in its design and evaluation much more strongly than has been the norm to date [22]. We will also need to have specific tools, and in addition better measurement techniques, so that we know the extent to which we have reached our goals. The kinds of research presented in this special issue of JBI will be essential for improving patient safety to the extent that policy makers, clinicians, and the public are increasingly demanding.

References


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