

## 2 Introduction

The explosion of social networking websites, mobile apps and consumer devices for tracking personal information has created many new detailed data sources about health and wellbeing. This information has been demonstrated to promote positive health behaviours, such as encouraging a healthy diet (Brown et al., 2006), assisting in recovery of cancer patients (Jacobs et al., 2014), and reminding people to take their medication (Stawarz et al., 2014). These benefits have led calls to investigate the use of consumer technology within health care (Swan, 2009). It has been proposed that such personal information can form a body of patient data to support clinical decision making, in turn leading to more accurate diagnoses, improved patient outcomes, and reduced mortality (Rooksby et al., 2014).

Recent research has revealed that clinical decision making is often negatively affected by cognitive bias, leading to preventable adverse events, worsened patient outcomes, and higher mortality (Crookery, 2013). Graber et al. (2002) states that cognitive bias is a major cause of preventable diagnostic error, but is extremely challenging to study and reduce. This complements earlier discoveries by Kahneman et al. (1982), in which people tend to use biases when making decisions under uncertainty, occasionally leading to severe errors. Many forms of cognitive bias have been identified – Wikipedia lists over 350<sup>1</sup> – however, the consequences of biases in clinical decision making remain largely unexplored (Crookery, 2013). It is thus unknown how the provision of patient data may affect bias in clinical decisions.

By conducting a literature review of research in cognitive bias over the last 50 years, this dissertation presents a list of 11 biases which may affect clinical decisions made when patient data is used. From this, it has been identified that supplementing patient data may introduce further bias due to methods clinicians use to interpret patient data. Furthermore, it has been found that these biases usually have a more significant effect when decisions are made in acute scenarios, such as emergency rooms, where decisions must be made quickly with limited resources.

For the purpose of this dissertation, decisions which involve patient data will be called *evidence-based clinical decisions*. The term *patient data* refers specifically to personal information which is collected by mobile apps and consumer devices, such as the number of steps taken, video lifelogs, location history and status updates on social networks. Patient data is subsequently *interpreted* by clinicians, which refers to the observation, analysis and sense-making of data.

The purpose of this literature review is threefold. First, in identifying biases which affect clinical decision making, this research raises consciousness to the effect of bias in evidence-based clinical decisions. In turn, it is hoped that clinicians' increased understanding of bias may help reduce the frequency of adverse events, improve patient

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<sup>1</sup>Wikipedia – List of cognitive biases [http://en.wikipedia.org/wiki/List\\_of\\_cognitive\\_biases](http://en.wikipedia.org/wiki/List_of_cognitive_biases)  
[Accessed 4th Sep 2014]

outcomes and reduce mortality. Second, in identifying the cases where biases are of high risk, this research proposes a number of steps which may be taken by data scientists and health scientists to debias evidence-based clinical decisions. Third, current research is limited in the area of bias in clinical decisions, and the effect of providing patient data has not yet been investigated. This research provides a framework for conducting such investigations by proposing a number of hypotheses formed from the identified biases.

The literature review is conducted in five stages. The first stage comprises of identifying cognitive biases that affect clinical decision making. This largely builds on previous research by Patrick Croskerry M.D., Ph D. (Division of Medical Education, Dalhousie University). The second stage comprises of identifying cognitive biases which affect data interpretation. This research involves searching in the Journal of Cognitive Psychology, and extracts from the books *Nudge: Improving Decisions About Health, Wealth and Happiness* (Thaler and Sunstein, 2012), *Thinking, Fast and Slow* (Kahneman, 2012) and *Predictably Irrational: The Hidden Forces that Shape Our Decisions* (Ariely, 2009). The third stage involves synthesising a list of biases which are the product of combining clinical decision making biases and interpretation biases. The fourth stage involves identifying how these biases are affected by restricting time and resources. This involves searching literature for empirical studies of the biases. Finally, stage five involves the categorising of biases by their risk factors and causes.

The disciplines involved in this research include Health Science, Cognitive Science and Computer Science. Each discipline has its own methodological and epistemological approaches, which limits how research from multiple disciplines can be synthesised (Repko, 2011). Therefore, this dissertation does not attempt to take a standpoint from any one discipline, and instead opts for an interdisciplinary perspective. The Web Science perspective is particularly useful in this case, as it concerns itself with the study of the World Wide Web within disciplines other than Computer Science. Hendler et al. (2008) states that “despite the Web’s great success as a technology and the significant amount of computing infrastructure on which it is built, it remains, as an entity, surprisingly unstudied.” It is hoped that the approach and findings in this dissertation will contribute to the growing field of Web Science.

In concluding, this dissertation argues that the findings from the literature review can be used to raise consciousness to the effect of biases in evidence-based clinical decision making. Suggestions are made for the design of patient data in order to minimise these biases, and methods of debiasing within clinical scenarios are proposed. Finally, an outline for future work in this area is proposed. This takes the form of a framework for future empirical studies within clinical scenarios. It is hoped that the findings from these studies will inform research of bias leading to better understanding of their nature and consequences.

This dissertation will first discuss the background material, detailing research related to personal informatics, healthcare informatics, decision economics and finally work from the emerging field of Web Science. Following a brief overview of the related work,

the research questions will be distilled and their importance underlined. The method for conducting this research will then be described, the results given, followed by a discussion. This dissertation will conclude by proposing a design of a study to observe biases within healthcare and discussing the future work.