Chapter 73

A Pharmaco–Cybernetics Approach to Patient Safety:
Identifying Adverse Drug Reactions through Unsupervised Machine Learning

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ABSTRACT

Pharmaco-cybernetics is an upcoming interdisciplinary field that supports our use of medicines and drugs through the combined use of computational technologies and techniques with human-computer-environment interactions to reduce or prevent drug-related problems. The advent of pharmaco-cybernetics has led to the development of various software, tools, and Internet applications that can be used by healthcare practitioners to deliver optimum pharmaceutical care and health-related outcomes. Patients are becoming more informed through health information on the Internet, which empowers them to better participate in the management of their own conditions. Focusing on patients with cancer, this chapter describes the use of a pharmaco-cybernetics approach to identify clinically relevant predictors of two debilitating adverse drug reactions, which are a cause of patient safety – chemotherapy-induced nausea and vomiting and febrile neutropenia. The early identification of such clinical predictors enables clinicians to prevent or reduce the occurrence of adverse drug reactions in cancer patients undergoing chemotherapy through appropriate management strategies. The computational methods used in this approach involve two unsupervised machine-learning techniques – principal component and multiple correspondence analyses. Using two case examples, this chapter shows the potential of machine-learning techniques for identifying patients who are at greater risks of these adverse drug reactions, thus enhancing patient safety. This chapter also aims to increase the awareness among healthcare professionals and clinician-scientists about the usefulness of such techniques in clinical patient populations, so that these can be considered as part of clinical care pathways to enhance patient safety and effectively manage cancer patients on chemotherapy.

INTRODUCTION

Pharmaceutical care is critical for improving medication management in patients, particularly those with chronic diseases. The practice of pharmaceutical care is the basis of clinical pharmacy and it involves identifying, preventing and solving drug-related problems with regards to patients' drug therapies (American Society of Hospital Pharmacists, 1993; Westerlund, Almarsdóttir, & Melander, 1999). Simply put, it helps patients make the best use of their medications. Drug-related problems exist in many forms, but essentially, they are events or circumstances involving drug therapies that can actually or potentially interfere with desired health outcomes (American Society of Hospital Pharmacists, 1993; van Mil, Westerlund, Hersberger, & Schaefer, 2004). Drug-related problems impact medication safety, and as a consequence, patient safety as well. The Pharmaceutical Care Network Europe Foundation categorizes drug-related problems in terms of problems and causes (Pharmaceutical Care Network Europe, 2010), while the American Society of Health-System Pharmacists classifies drug-related problems into eight main categories - see Figure 1. Drug-related problems can result due to a lack of knowledge or misinterpretation of drug information, which can compromise patients' safety and quality of life if not treated effectively and appropriately.

Cancer is a highly prevalent health problem with increasing incidence worldwide. In 2007, one in 8 deaths was due to cancer (Garcia et al., 2007). The global burden of cancer is also expected to grow to 27 million new cancer cases and 17.5 million cancer deaths by 2050 (Garcia et al., 2007). The rapid growth of informatics technologies and the World Wide Web in the last decade has enabled the development of many applications that can assist clinicians in delivering optimum pharmaceutical care and health-related outcomes. Patients with cancer are becoming more well informed through online health information that is readily accessible, and they can better participate in the management of their own conditions through knowledge obtained from the Internet. However, despite the advancement of informatics technologies, little has been done in clinical oncology practice to leverage on the use of these

Figure 1. List of drug-related problems
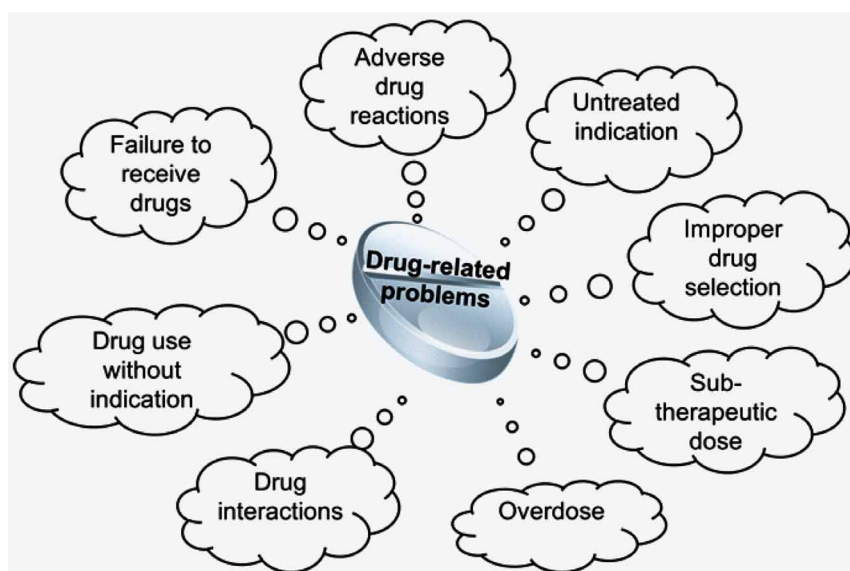
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