

Quality of Life Research: A Critical Introduction

2014 IEEE 27th International Symposium on Computer-Based Medical Systems

Using probabilistic graphical models to enhance the prognosis of health-related quality of life in adult survivors of critical illness

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Abstract—Health-related quality of life (HR-QoL) is a subjective concept, reflecting the overall mental and physical state of the patient, and their own sense of well-being. Estimating current and future QoL has become a major outcome in the evaluation of critically ill patients. The aim of this study is to enhance the inference process of 6 weeks and 6 months prognosis of QoL, after intensive care unit (ICU) stay, using the EQ-5D questionnaire. The main outcomes of the study were the EQ-5D five main dimensions: mobility, self-care, usual activities, pain and anxiety/depression. For each outcome, three Bayesian classifiers were built and validated with 10-fold cross-validation. Sixty and 473 patients (6 weeks and 6 months, respectively) were included. Overall, 6 months QoL is higher than 6 weeks, with the probability of absence of problems ranging from 31% (6 weeks mobility) to 72% (6 months self-care). Bayesian models achieved prognosis accuracies of 56% (6 months anxiety/depression) up to 80% (6 weeks mobility). The prognosis inference process for an individual patient was enhanced with the visual analysis of the models, showing that women, elderly, or people with longer ICU stay have higher risk of QoL problems at 6 weeks. Likewise, for the 6 months prognosis, a higher APACHE II severity score also leads to a higher risk of problems, except for anxiety/depression where the youngest and active have increased risk. Bayesian networks are competitive with less descriptive strategies, improve the inference process by incorporating domain knowledge and present a more interpretable model. The graphical models and different factors extracted by the Bayesian models are in accordance with those collected by previous state-of-the-art literature, hence showing their usability as inference model.

Keywords—quality of life; intensive care; Bayesian networks; critically ill patients; EQ-5D.

I. INTRODUCTION

This study was built on two main concepts: health-related quality of life after critical illness, and Bayesian inference for outcome prognosis.

A. Health-related quality of life after critical illness

During the past decade, health related quality of life (HR-QoL) has emerged as an important outcome in clinical research, and decision making in critical care patients has become highly influenced by the appreciation of patients' future HR-QoL. In critically ill patients, prolonging life could

result in a health outcome that may be considered worse than death [1]. In this setting, the ideal outcome for the patient is to return to their pre-existing state or that expected for a person of the same age and medical condition [2]. The interest in patients' perspectives in the evaluation of health care has led to the development of numerous measures. Measures of outcome have thus changed from objective measures toward subjective measures of functional status and HR-QoL, with data directly collected from patients [2].

HR-QoL can be conceived as a subjective concept, primarily reflecting individual patient attitude. Measuring HR-QoL is in essence evaluating the health state of individuals, both mental and physical, together with their own sense of well-being [3]. HR-QoL is more complex to record and analyze than survival or other objective measures due to a number of reasons: first, the timing of data collection from critically ill patients; then the choice of particular dimensions to be included; difficulties in consensus over the instrument to be used; and finally, the interpretation of the results [4-5]. EQ-5D has been recommended as one of the questionnaires suitable to apply to critical care survivors for measuring quality of life [6], and has been validated in critically ill patients [7]. It is a simple questionnaire, of easy comprehension and quick answers. The EQ-5D comprises two parts: a self-reported description of health problems according to five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression; and the EQ-VAS, a self-rated health status using a visual analogue scale (VAS), to record perceptions of the current overall health state [8, 6].

B. Bayesian networks for decision support

The definition of clinical decision support systems is now a major topic since it may help the diagnosis, the prognosis of mortality, the prognosis of quality of life, or even therapeutic options. However, the complicated nature of real-world biomedical data has made it necessary to look beyond traditional biostatistics [9] without losing the necessary formality. For example, naive Bayesian approaches are closely related to logistic regression [10]. Traditional statistical methods require that the model structure is given and only probabilistic information is learned from biomedical evidence, in the form of data, whereas machine-learning approaches

1063-7125/14/\$31.00 © 2014 IEEE
DOI: 10.1109/CBMS.2014.31

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