MA16-045 - Optimal gender-specific treatment paths on healthcare multiplex networks

Abstract

Project results

In many countries, the aging of the population is leading to an increase in chronic diseases such as diabetes and cardiovascular diseases (CVD). Such diseases are often accompanied by a multitude of pre-existing and secondary diseases. As a result, many individuals, particularly the elderly, have multiple conditions (multimorbidity) and therefore need to seek many therapies from a variety of health care providers. The goal of this project was to improve our understanding of these relationships using data-driven, mathematical approaches with particular attention to gender differences. Such understanding is the basis for targeted interventions for early identification and prevention of chronic disease.

The central innovation of this project was the development of a formalism for networks of treatment paths, i.e., for typical temporal sequences of hospitalizations, physician visits, etc. The project was based on comprehensive, population-based data. Based on data sets from the Austrian health care system, we developed algorithms to extract networks of treatment paths and to examine them for gender differences.

The project yielded three key results. First, network models were developed to describe how multimorbidity evolves over the life course. This enabled the identification of critical events that significantly increase the risk of dying from CVD in later life. Patients with diabetes develop diabetic complications much faster if they have hypertension and dyslipidemia. Depression, smoking or obesity further accelerate this development. Our approach can thus be used for the targeted identification of population groups using already available health data who can particularly benefit from offers such as preventive check-ups and disease management programs.

The second key result is a methodology for directly comparing the development of multimorbidity in women and men. Many CVDs occur more frequently in men than in women. However, our work has shown for a number of conditions (e.g., myocardial infarction or coronary artery disease) that they are more common in women than in men when certain risk factors, such as smoking or diabetes, are present. These results emphasize the importance of screening for CVD in women and the need to sensitize physicians to these sex differences.

The third central result is a network model of the use of physicians by multimorbid patients before and after hospitalization. We were able to show that men had a higher risk of being hospitalized again after a hospital stay due to a chronic illness. However, contacts with physicians in private practice were able to halve this risk. By analyzing networks of patient flows between physicians, resilience indicators could be developed for individual medical specialties and regions.

The outbreak of the SARS-CoV-2 pandemic occurred in the middle of the project's duration. This also made network models of infectious diseases an urgent topic. We developed a series of simulation models to evaluate the effectiveness of interventions to reduce the spread of infection. Our study evaluating the effectiveness of more than 6,000 interventions in 79 territories during the first wave of infections ranked 36th among all scientific publications in 2020, according to an Altmetric attention ranking.

Scientific disciplines:
Statistical physics (60%) | Gender medicine (25%) | Graph theory (15%)

Keywords:
multiplex networks, gender medicine, diffusion on networks

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Further links to the persons involved and to the project can be found under
https://www.wwtf.at/funding/programmes/past/ma/MA16-045/