A two-dimensional multistate Markov model with application for myocardial infarction and stroke recurrence

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Abstract

BACKGROUND: In Taiwan, similar with other developed countries, cardiovascular disease (CVD) and cerebrovascular disease were the 2nd and 3rd leading causes of mortality in 2011, respectively. Both MI and stroke are triggered by the rupture of lipid-rich plaques in the arterial wall during progression of atherosclerosis. Survivors of acute coronary syndromes have a high risk of recurrent events.

METHOD: Because of medical treatments following heart attack or stroke for primary and secondary prevention, the first episode is regarded as a different state with subsequent recurrent events. Also, an individual with more than one episode of MI and stroke may indicate certain correlation between the two events due to similar mechanism. Therefore, it is regarded as different state with recurrent MI or stroke alone. In this study, we propose a bivariate Markov model to deal with the multistate of recurrent events of MI and stroke, with loss of follow-up considered as an additional state. Assume that the bivariate survival times of MI and stroke follows the bivariate exponential distribution (BVE) of Sarkar (1987), we analyzed the hospital admission records of ischemic MI and/or stroke of the National Health Insurance (NHI) database in Taiwan (2000-2010).

RESULTS: Of the totally 460,189 individuals aged 30 and above, 2637 (0.57%), 12037 (2.62%), and 348 (0.08%) developed MI, stroke, and both events, respectively. Younger

male (aged 30-44) tended to have a much higher risk of developing MI or stroke (RR 9.2 and 1.7, respectively) compared to that of the younger female. The RR of middle-aged (aged 45-54) and older (aged 55 and above) male vs. female were 3.9 (1.6) and 1.8 (1.0) for MI (stroke), respectively. For those who had MI or stroke during the 9 y follow-up period, the probability of recurrent event of MI, stroke, and either event within one year was 0.02 and 0.05, and 0.02, respectively.

<u>CONCLUSIONS</u>: Using the proposed bivariate multistate Markov model, the joint disease progression of MI and stroke can be described appropriately by the Sarkar's BVE, which cannot be assessed by conventional recurrent event method.

Keywords: multi-type recurrent event, semi-markov process, progressive process, joint modeling, transition probability, censoring