Multistate Models for Survival Analysis of Cardiovascular Disease Process

Modelos multiestado para el análisis de supervivencia en procesos de enfermedad cardiovascular

To the Editor,

Noncommunicable diseases (NCD) are a major cause of death worldwide. About 63% of the 57 million global deaths in 2008 were due to NCD, which are also on the rise every year.[1] Four important NCD include cardiovascular diseases, chronic pulmonary diseases, cancers, and diabetes. The World Health Organization has focused on 4 main serious contributors to NCD: an unhealthy diet, cigarette smoking, excessive alcohol consumption, and physical inactivity. Ischemic heart diseases and cerebrovascular diseases were and are predicted to be the 2 leading causes of death in 2002 and 2030.[2,3] With an aging population and advances in the diagnosis of cardiovascular diseases in Iran, we are seeing a considerable increase in the incidence of cardiovascular diseases. However, despite good progress in the treatment of these diseases, the mortality rate from cardiovascular diseases remains high.[4,5]

A main determining factor concerning NCD is their early detection. Unless medical staff detect an NCD as early as possible, it will lead to chronic conditions, imposing a large financial burden on families and the health care system over time. In recent years, advanced statistical methods such as advanced regression models, artificial neural networks, Markov and hidden Markov models, and decision trees, to mention a few of them, have been developed to lead to more accurate and earlier detection of various diseases.

There are a wide range of methods to evaluate the clinical characteristics and cardiovascular disease process. Furthermore, clinicians are interested in both the final outcome and the dynamics of the process itself. To improve understanding of disease prognosis, a series of models are suggested that simultaneously consider progression, the mortality rate, and related factors.

Multistate models are stochastic processes in which patients could occupy different intermediate states (disease conditions) before the final outcome at any time.[6] In medical applications, the states may represent remission, different severities of the disease, discharge, or hospital infection. The effect of treatment and risk factors could be investigated using multistate models through patients' transitions in various states. Some associated factors

depend on time, eg, recurrence of a specific event (such as heart failure or myocardial infarction). The best approach to take into account for these kinds of variables in cardiovascular diseases is multistate models, while other methods have some limitations for time-dependent variables. Despite the importance of cardiovascular diseases and, given the fact that by 2030, the leading causes of death in the high-, middle- and low-income countries will be cardiovascular diseases,[2] there are few studies about the application of multistate models in cardiovascular diseases. Two examples are Ieva et al[7] and Zhang et al.[8]

To sum up, multistate models can lead to early detection, improved disease prognosis, and reduced cost of the disease for families and governments, which are the main concerns of ministries of health and other policymakers. Therefore, it is suggested that this model be more focused on by policymakers to save financial resources and reduce the costs of the health system.

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REFERENCES

1. Alwan A, MacLean DR, Riley LM, D'Espaignet ET, Mathers CD, Stevens GA, et al. Monitoring and surveillance of chronic non-communicable diseases: progress and capacity in high-burden countries. Lancet. 2010;376:1861–8.
2. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006;3:e442.
3. Pouche M, Ruidavets JB, Ferrieres J, Iliou MC, Douard H, Lorgis L, et al. Cardiac rehabilitation and 5-year mortality after acute coronary syndromes: The 2005 French FAST-MI study. Arch Cardiovasc Dis. 2016;109:178–87.
4. Forouzanfar MH, Sepanlou SG, Shahraz S, Dicker D, Naghavi P, Pourmalek F, et al. Evaluating causes of death and morbidity in Iran, global burden of diseases, injuries, and risk factors study 2010. Arch Iran Med. 2014;17:304–20.
5. Kazemi T, Nik M. ''World heart day 2014'', significance of cardiovascular diseases in East of Iran. J Res Med Sci. 2015;20:423.
6. Schmoor C, Schumacher M, Finke J, Beyersmann J. Competing risks and multistate models. Clin Cancer Res. 2013;19:12–21.
7. Ieva F, Jackson CH, Sharples LD. Multi-state modelling of repeated hospitalisation and death in patients with heart failure: The use of large administrative databases in clinical epidemiology. Stat Methods Med Res. 2015 Mar 26. pii: 0962280215578777. [Epub ahead of print].
8. Zhang X, Li Q, Rogatko A, Tighiouart M, Hardison RM, Brooks MM, et al. Analysis of the bypass angioplasty revascularization investigation trial using a multistate model of clinical outcomes. Am J Cardiol. 2015;115:1073–9.

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