Estimation of patient flow in hospitals using up-to-date data. Application to bed demand prediction during pandemic waves

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Hospital bed demand forecast is a first-order concern for public health action to avoid healthcare systems to be overwhelmed. Predictions are usually performed by estimating the number of patients admitted to hospital and simulating these inpatients pathways. This requires estimating the distribution of lengths of stay in different hospital facilities such as ward and ICU, and the corresponding branching probabilities. In most approaches in the literature, estimations are parametric and rely on not updated published information or historical data. This may lead to unreliable estimates and biased forecasts during new or non-stationary situations. We introduce a flexible adaptive procedure to estimate efficiently these probabilities and lengths of stay using only near-real-time information of inpatients. The main challenge of using up-to-date patient-level information is that data provided by patients still in hospital ward at the time of estimation is censored, as the future path of these patients remains unknown. We show that methods that take advantage of the partial information associated to these patients using mixture cure models (MCM) are more efficient that naive methods that do not use survival analysis techniques. This is very relevant, for example, at the first stages of a pandemic, when there is much uncertainty and too few patients have completely observed pathways. The performance of the proposed method is assessed in an extensive simulation study in which the patient flow in a hospital during a pandemic wave is modelled. We further discuss the advantages and limitations of the method, as well as potential extensions.

Keywords: EM algorithm, length-of-stay estimation, mixture cure model.

References

1. García-Vicuña D., López-Cheda A., Jácome M.A., Mallor F. (2023). Estimation of patient flow in hospitals using up-to-date data. Application to bed demand prediction during pandemic waves. *PLOS ONE* 18(2): e0282331. doi: 10.1371/journal.pone.0282331