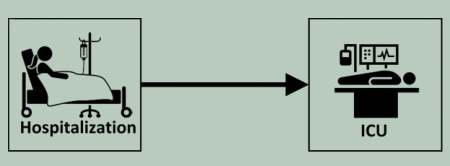
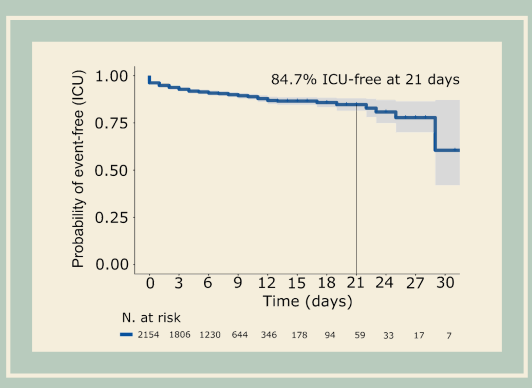
MULTI-STATE MODELS

A multi-state model is a method to estimate probabilities of transition between stages of a disease

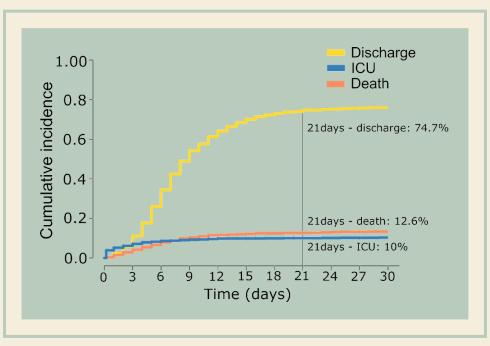
SIMPLE MODEL



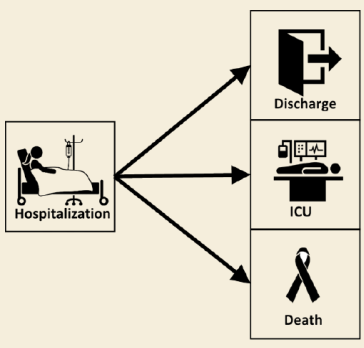
Survival analysis studies the time from an origin to an event of interest, e.g., the time from hospitalization until ICU admission. This time was analyzed with the data on more than 2,000 COVID-19 patients from HM hospitals between 5th February and 20th April 2020. Survival analysis can be used to estimate the probability that a COVID-19 patient is not sent to the ICU after, for instance, 21 days from being hospitalized.



Kaplan-Meier curve. The probability that a patient is not sent to ICU equals 84.7% after 21 days.



Cumulative incidence curves. Cumulative probabilities, since hospitalization, of discharge (75%), ICU (10%) and death (13%) up to 21 days.

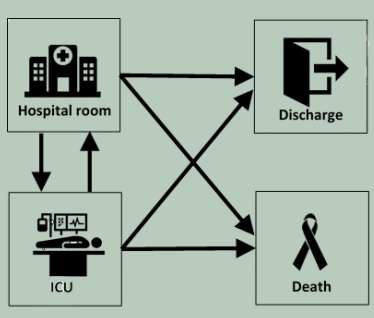


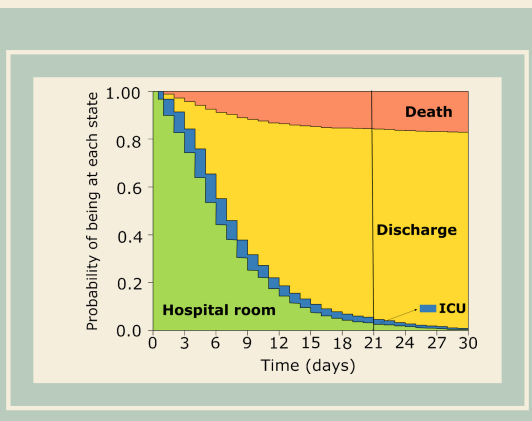
COMPETING RISKS MODEL

Competing risks (CR) models study the times to different events taking into account that some of them, for instance death, prevent the observation of the others. These CR models allow to estimate the probability ("cumulative incidence") that either of these events occurs first before a given time. For example, the cumulative probability of entering ICU up to 21 days before discharge or death is 10%.

MULTI-STATE MODEL

Multi-state models (MSM) dynamically analyze patients' shifts from one disease state to another. The states of the disease course of COVID-19 hospitalized patients would be, for example, hospital room, ICU, discharge, and death. MSM permit to estimate the survival probabilities as well as probabilities of transition and of being in a given state. For instance, almost 20% of patients are in the hospital room after 12 days.





State probabilities. Probabilities of being in Room, ICU, Discharge or Death at day 21 are 3%, 3%, 78% and 16%, respectively.

FINAL REMARKS

Multi-state models, including survival analysis and competing risks models as particular cases, are powerful tools to model the course of a disease, to calculate the probabilities of changing from one state to the other and to identify prognostic and risk factors specific for each state. They can help us to gain insight into the disease course and contribute to its control and prevention.

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