A Systematic Review of Risk Prediction Models for Central Line-Associated Bloodstream Infection (CLABSI) in Hospitalized Patients

Shan Gao, Elena Albu, Ben Van Calster, Laure Wynants

KU LEUVEN

BACKGROUND

According to the ECDC, 7% of the inpatients in Europe get a HAI

- 2,268 patients in Belgian acute hospitals with CLABSI (2016)
- 30% increase in mortality risks for patients who get infected
- 2018 incidence rate ~ 2.0 CLABSI per 10,000 inpatient days (Sciensano, 2019)
- Annual excess health care cost in Belgium ~ 30-90 million euro
- Average increased length of stay ~ 10 days
- CLABSI can be prevented through timely removal of at-risk catheters or antimicrobial therapy applied
- This project attempts to evaluate the current risk prediction models developed for CLABSI, and to highlight the practical questions raised regarding the implementation of these models

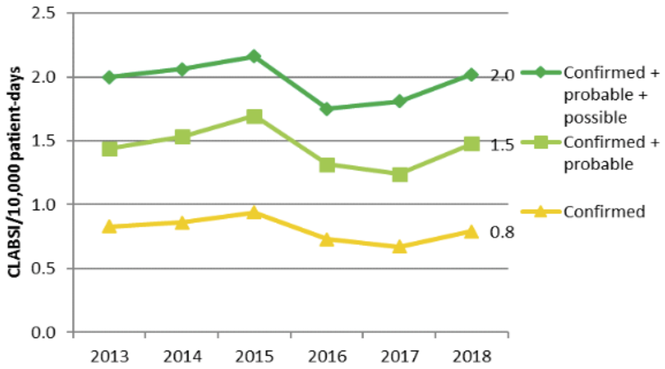


Figure 1: Mean incidence central line-associated bloodstream infection (CLABSI) per 10,000 patient days, Belgium 2013-2018
Source: Surveillance of Bloodstream infections in Belgian Hospitals, workgroup meeting, 19 November 2018

Methods

With adherence to PRISMA guidelines for systematic review, we searched PubMed (including MEDLINE), Embase (Embase.com), Web of Science Core Collection and Scopus for all relevant articles

Eligibility criteria:

- ✓ They describe the development or validation of a prediction model for CLABSI
- ✓ They have at least two predictor variables to build multivariable predictive models
- ✓ Both English & non-English articles eligible
- ✓ Target population includes inpatients with any central lines, without age limits

Eligibility criteria:

- × They do not report original research (i.e. reviews)
- × They are not full papers (i.e. letters, notes and conference abstracts)
- × They are qualitative studies
- × Risk predictor finding studies or diagnostic models are not of our goal

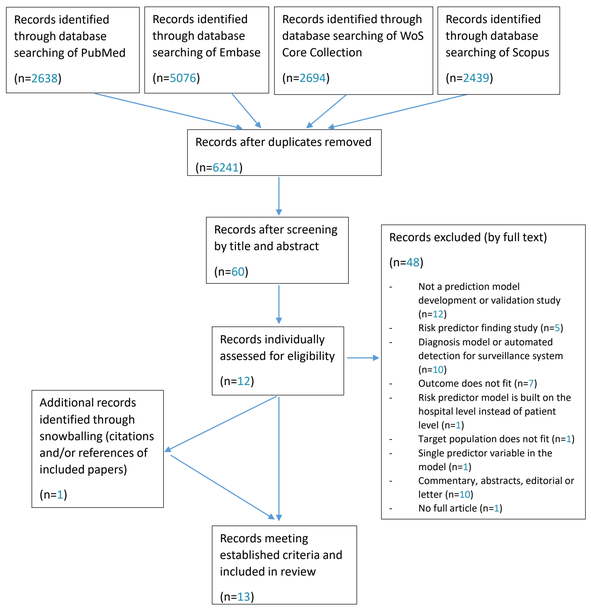


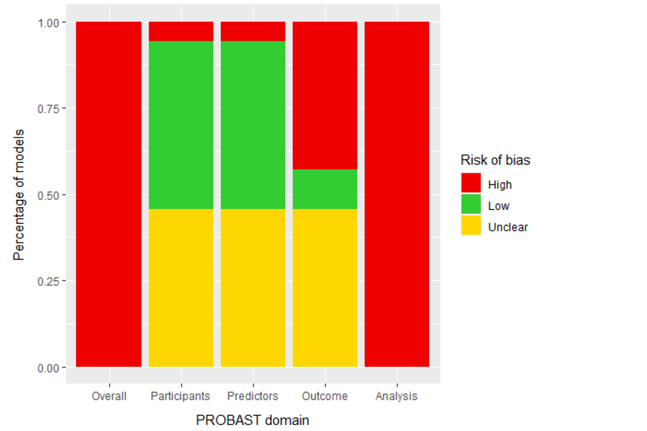
Figure 2: PRISMA flowchart

Results

- Of the 13 unique articles resulting from our search strings, overall 35 models matched our eligibility criteria
- More than half of the studies were conducted in US and use registry data
- Of the 35 models, 20 (57%) of them are development only studies, 14 among (40%) them are development and internal validation study, only 1 model is external validation
- Type of settings include: hospital-wide 25 (71)%; ICU 7 (20%); other hospital wards 3 (9%)
- 23 models are developed based on patients at any age, 6 models are built for adult patients above 18, while the other 6 models are for children only

DISCUSSION

- All models suffers from high risk of bias for analysis, which indicates a poor modeling for CLABSI, possible source of bias might include:
  - Lack of report on missing values and how they are dealt with
  - Sample size is too small
  - Model performance is not sufficiently reported, most models reports C-statistics without checking calibration, or naïvely use apparent performance only
  - Predictor selection based on univariate analysis
- Quite high risk of bias on outcome domain is also reported, due to the lack of information on the specific definition they applied during the study



Conclusion

- To our knowledge, this is the first systematic review of risk prediction models for CLABSI
- All models suffer from high risk of bias for analysis domain
- A number of practical problems need to be addressed when implementing the risk prediction models, including:
  - Following which criteria is the outcome defined and measured, especially the time interval needs to be considered to get more blood sample excluding the possibility of secondary BSIs
  - Timing of the predictor availability by the use of prediction tool, e.g., laboratory values may not be available at the day of sample collection
  - Considering the popularity of registry data, more information on the variables such as repeated measurements every single day might be available, how to incorporate the dynamic nature into modeling worth thinking