Critical Appraisal of Models that Predict Readmission

We present 15 Delphi-based expert recommendations to critically appraise the development and validation of a given readmission risk prediction model.

◆ #1. Is the model's purpose and eligibility criteria explicitly stated?
The model should state one or both purposes: (1) to identify patient candidates for targeted interventions to prevent readmission, or (2) to risk-adjust readmission rates for hospital quality comparison.

◆ #2. Does the model consider common patient- and institution-related risk factors for readmission?
Common risk factors frequently included in previous models may include demographics, disease-related, functional ability, healthcare utilization, medication-related, social determinants of health, and institution-related.

◆ #3. Does the model consider competing risks to readmission, particularly mortality?
Developers should indicate that they accounted for both in-hospital and post-discharge mortality, as well as other competing risks to readmission (e.g., transfers).

◆ #4. Does the model identify how providers may intervene to prevent readmission?
Such a model may: (1) identify modifiable factors on the individual level, or (2) identify which individuals will benefit most from intervention, which may not coincide with readmission risk.

◆ #5. Does the model consider recent changes in the patient’s condition?
Models which give predictions near hospital discharge should account for changes during hospitalization, including treatment effects, hospital-acquired conditions, and social support status.

◆ #6. Is the model’s timeframe an appropriate trade-off between sensitivity and statistical power?
Developers should consider assessing prediction accuracy using multiple timeframes, as relevant to the clinical context and dataset size, to determine the best trade-off between sensitivity and statistical power.

◆ #7. Does the model exclude either planned or unavoidable readmissions?
Planned readmissions should be excluded as consistent with the standardized definition of all-cause readmission, and unavoidable readmissions may be excluded more broadly when useful.

◆ #8. Is the model equipped to handle missing data and is missingness in the development datasets reported?
Developers should explicitly state whether their model handles missingness and how, and should report on missingness in the datasets used for model development.
#9. Is preprocessing discussed and does the model avoid problematic preprocessing, particularly binning?
Developers should explain their data preprocessing methods, and should avoid problematic preprocessing methods such as binning, which can lead to valuable information loss.

#10. Does the model make use of all available data sources to improve performance?
Developers should make use of publicly-available data sources where possible and appropriate to the model's purpose. Data sources such as health information exchanges can help assess readmission at multiple institutions.

#11. Does the model use electronically-available data rather than relying on manual data entry?
Developers should incorporate risk factors which will be available electronically at the time of prediction, and avoid manual data entry by providers or research assistants.

#12. Does the model rely on data available in sufficient quantity and quality for prediction?
Developers should rely on data that institutions will have access to in sufficient amounts and quality, and conduct automated quality assurance as needed.

#13. Is the model internally validated using cross validation or a similarly rigorous method?
Split-sample validation is insufficient. If the model is intended for generalized use at more than one institution, confirm external validity using one or more external, representative, and independent datasets.

#14. Is the model's discrimination reported and compared to known models where appropriate?
Discrimination should be prominently and clearly reported using appropriate and well-known measures. If models already exist for similar populations, compare performance.

#15. Is the model calibrated if needed and is calibration reported?
Calibration should be performed if needed and reported independently from discrimination. It is commonly accepted practice to report calibration using calibration curves with no binning.