



# 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.