Risk scores for use in community dwelling adults to predict emergency hospital admissions: a systematic review.

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**Background**

Emergency hospital admissions, defined as unexpected events occurring at short notice and based on assumed clinical need, are estimated to account for over one third of all hospital admissions in England with approximately 5.2 million episodes between 2011 and 2012 (1). Two thirds of these admissions are related to chronic medical conditions.(2, 3) Other factors contributing to higher emergency admission rates include socio-economic deprivation and increasing age.(4)

Reducing emergency hospital admissions is a priority for health care providers globally due to spiralling healthcare expenditure. It has been estimated that these types of admissions cost the National Health Service (NHS) in the United Kingdom (UK) approximately £11 billion annually.(5) Since October 2012, the Centres for Medicare and Medicaid Services in the United States (US) have introduced hospital directed financial penalties in an attempt to curb excess 30 day readmissions.(6) Being admitted to hospital, especially for older people, is associated with an increased risk of adverse clinical events including falls, functional decline and nosocomial infections. (7, 8) Medical inpatients are also vulnerable to adverse drug related events such as errors at the transition points in care (e.g. at discharge). (9)

Strategies to reduce emergency hospital admissions include the use of risk prediction models in order to identify patients at higher risk of hospital admission or readmissions following discharge from hospital. A recent systematic review which focussed on hospital readmission risk models applied to medical inpatients and predicting readmission to hospital following discharge concluded that overall these models perform poorly and that efforts are needed to address improving their utility.(10) It could be argued that a shift in emphasis from hospital readmission models developed utilising inpatient cohorts and usually predicting 30 to 90 day readmission rates following discharge, to risk scores developed for use in community dwelling populations predicting emergency hospital admission may offer potential. One
example is the Probability of Repeated Admission (Pra) score, a self report questionnaire, developed in older community dwelling adults in the US and subsequently validated for use in European populations.(11, 12) A recent systematic review of this score indicates that it performs well in identifying older people at high risk of emergency hospital admission in the following year.(13) Those identified using these models may then benefit from targeted interventions to reduce their risk of subsequent hospital admission.(14) Other risk scores have been developed for this purpose including the Predicting Emergency Admissions Over the Next Year (PEONY) score based on a UK population-derived algorithm but directed to younger populations, aged 40 to 65 years and the Emergency Admission Risk Likelihood Index (EARLI) score, which, similar to the Pra score, uses a short postal questionnaire focusing on physical functioning and cognitive impairment. (15, 16)

This study aims to carry out a systematic review of validated risk prediction scores developed for use in community dwelling adults in order to assess their performance in predicting emergency hospital admission.

**Methods**

The PRISMA guidelines for the reporting of systematic reviews will be utilised in the conduct of this systematic review. (17)

*Search strategy*

A systematic literature search will be conducted and will include the following search engines; PubMed, EMBASE, CINAHL and the Cochrane Library. Grey literature will be searched using Google scholar, Open Grey, Dart Europe, the Agency for Healthcare Research and Quality (AHRQ) and the Health Management Information Consortium (HMIC) database. The search will be supplemented by handsearching references of retrieved articles. No restrictions will be placed on language or year of publication.

A combination of MeSH terms and keywords will be used to capture studies of interest under the following headings
Population; Community dwelling adults (aged $\geq 18$ years)

**AND**

Intervention; Risk score derived and validated in at least one cohort

**AND**

Outcome; Emergency hospital admission, emergency department visits

*Study selection*

Studies will be included if they meet the following inclusion criteria:

Study type; Prospective or retrospective cohort studies which assess the performance of a risk score with a derivation and at least one validation cohort.

Type of participants; Community dwelling adults (aged $\geq 18$ years). Hospital inpatients will be excluded.

Primary Outcome: Emergency hospital admission (defined as unplanned overnight stay in hospital).

Secondary Outcomes: Healthcare utilisation e.g. Out-Patient Department visits, Emergency Room visits, GP visits etc and costs of care

*Data extraction*

Two reviewers (EW, ES) will read the titles and/or abstracts of the identified records and eliminate irrelevant studies. Studies that are considered eligible for inclusion will be read fully in duplicate and their suitability for inclusion will be determined. Disagreements will be managed by consensus. Additional data will be sought from authors where necessary.

Data will be extracted on;
• Author and year
• Study setting
• Patient demographics
• Outcomes (primary and secondary)
• Timing of hospital admission
• Risk score discrimination and calibration
• How outcome was measured e.g. patient self report, dataset etc

**Methodological Quality Assessment**

Methodological quality assessment of included studies will be independently performed by EW and ES using the McGinn checklist for the methodological assessment of clinical prediction rule validation studies. (18) This tool will be modified to ensure it is applicable to the included validation studies.

**Statistical Analysis**

We aim to perform a meta-analysis of the validation studies of each retrieved risk score to allow comparison of the performance of available models. Stata version 10.1 (StataCorp College Station, Texas, USA), particularly the metandi commands, will be used for all statistical analyses. 2x2 tables will be constructed using the recommended cut points to extract the number of true positives, false positives, true negatives and false negatives for each risk score from each of the original validation studies.

We will apply the bivariate random effects model to estimate the summary estimates of sensitivity and specificity and their corresponding 95% confidence intervals for the primary outcome of hospital admission. This approach is applied as it preserves the two-dimensional nature of the original data and takes into account both study size and heterogeneity beyond chance.
between studies.(19) We will also report the c statistic with 95% CI to
describe model discrimination.

Individual and summary estimates of sensitivity and specificity for each risk
score will also be plotted in a receiver operating characteristic (ROC) graph,
plotting the rules sensitivity (true positive) on the y axis against 1-specificity
(false negative) on the x axis. We will also plot the 95% confidence region
and the 95% prediction region around the pooled estimates to illustrate the
precision with which the pooled values were estimated (confidence ellipse
around the mean value) and to illustrate the amount of between study
variation (prediction ellipse).

We will evaluate heterogeneity visually using the summary ROC plots and
statistically using the variance of logit transformed sensitivity and specificity,
with smaller values indicating less heterogeneity among studies.

However, if we are unable to perform meta-analysis due to excess
heterogeneity or insufficient studies we will narratively summarise the
following for each retrieved risk score under the following headings;

- Variables included in the model
- The model’s derivation cohort including study setting, population and
  performance
- Number of validation cohorts and the populations studied
- Model discrimination will be assessed using the c statistic with 95% CIs
  where available. A c statistic of 0.5 indicates that the model performs
  no better than chance, 0.7-0.8 indicates acceptable discrimination
  while a score of >0.8 indicates good discrimination. (20) If the c
  statistic is not reported then other measures such as sensitivity and
  specificity will be recorded.
• Model calibration will be recorded where available by recording the range of observed admission rates compared to the predicted admissions as determined by the risk score.

We will also perform a subgroup analysis where data permits;

• Setting of participants e.g. residential care versus non residential care

• Population age i.e. Older (aged ≥70 years) versus participants aged ≤70 years

**Discussion**

Summary of findings; implications of findings; strengths and limitations of study, future perspectives; conclusions.
References