Risk prediction of 30-day unplanned re-admission or mortality for HF patients: external validation of the OPERA model

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Highlights

- The OPERA model performed well when tested in a different healthcare system and geography (in US) supporting transportability of the model beyond one single site.
- Taking frailty into account (physical and social) can improve prediction of outcomes following discharge from the hospital after an admission for HF.
- Predicting 30day readmissions with high accuracy remains challenging because of the multidimensional root causes of the events.

SAPHIRE-HF: a prospective, observational study

- SAPHIRE is a prospective cohort study enrolling patients hospitalized for HF in a tertiary care hospital in the US (Mercy Hospital in St. Louis, Missouri).
- Data was collected from electronic medical records.
- Additional questionnaires were administered to the patients once during hospitalization about general demographics, socioeconomic issues, prior hospitalizations, functional limitations and ability to self-care. For frailty assessment, the patients were asked to undergo the timed 'get up and go' test.

OPERA model

- 30-day unplanned readmission or mortality prediction model developed on data from 1094 HF patients from the UK
- The model includes clinical factors (increasing daily pill counts at admission, being in sinus rhythm at admission, dyspnea at rest, NYHA class III or IV, increasing urea and NT-proBNP at discharge, length of stay in the hospital and number of prior emergency hospitalizations in 6 months) combined with physical frailty, not being married, and not perceiving family support.

Statistical analysis

- Multivariable logistic regression analysis was applied to compare the effect of the predictors in the two cohorts. Odds ratios (ORs) were calculated with 95% confidence intervals (CIs) (Table 1). Multiple imputation was used to impute missing data.
- Discrimination and calibration were used to assess the external validity of the OPERA model. Discrimination refers to the ability to distinguish patients who will be readmitted from those who will not, and was quantified by the AUC (Table 1 – Validation). Calibration was assessed visually with a calibration plot (Figure 1).
- The model was further refitted to the SAPHIRE-HF patients and internally validated by a bootstrapping procedure. Finally, we combined both cohorts and refit the model to derive a final model optimized for both sites.
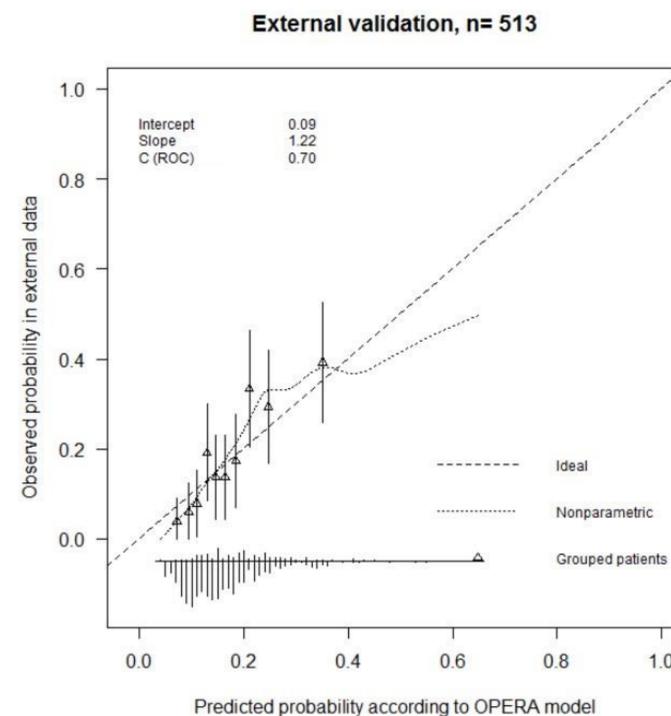

Figure 1. Calibration plot for the external validation of the OPERA model on SAPHIRE-HF data; the triangles indicate the observed frequencies by deciles of predicted probabilities with 95% confidence intervals (vertical lines); the distribution of patients having vs not having an event is shown at the bottom of the graph

Results

- Among 513 study participants diagnosed with HF, 72 (14%) had an unplanned all-cause readmission and 27 (5%) died within 30 days after discharge from the hospital.
- When applied on SAPHIRE-HF, the model showed a similar AUC and provided accurate risk estimations (predicted 17%, observed 18%). By refitting the predictors to the SAPHIRE HF cohort, the model performance was improved further (AUC 0.72 [95% CI 0.66 – 0.78]) (Table 1).

Variable	OPERA model (N = 1094) OR (95 % CI)	Refitted model (N = 513) OR (95 % CI)	Combined model (N = 1607) OR (95 % CI)
Number of daily pills at admission	1.03 (1.00 – 1.06)	1.01 (0.96 – 1.05)	1.02 (1.00 – 1.04)
Sinus rhythm at admission	0.77 (0.57 – 1.06)	0.65 (0.40 – 1.06)	0.75 (0.58 – 0.97)
Urea, mmol/l (log) at discharge	1.61 (1.22 – 2.13)	2.45 (1.55 – 3.88)	1.74 (1.37 – 2.20)
NT-proBNP pg/mL (log) at discharge	1.07 (0.94 – 1.21)	1.02 (0.85 – 1.23)	1.07 (0.97 – 1.19)
NYHA class at discharge, 1-class increase	1.40 (1.08 – 1.82)	Not available	1.48 (1.19 – 1.85)
Dyspnea at rest at discharge	1.72 (0.98 – 3.04)	Not available	1.37 (0.83 – 2.28)
Length of stay, 10-days increase	1.07 (0.96 – 1.20)	1.37 (0.88 – 2.13)	1.07 (0.97 – 1.18)
Prior EM hospitalizations in 6months	1.26 (1.10 – 1.45)	1.22 (0.96 – 1.54)	1.24 (1.10 – 1.40)
Physical frailty	1.21 (0.73 – 2.00)	2.24 (1.31 – 3.84)	1.73 (1.20 – 2.49)
Married	0.72 (0.53 – 0.97)	1.05 (0.63 – 1.73)	0.79 (0.61 – 1.02)
Perceiving support from family	0.74 (0.53 – 1.02)	0.64 (0.36 – 1.14)	0.80 (0.62 – 1.04)
Validation			
	Original	External validation	Refitted	Combined
AUC [95% CI] (Bootstrap optimism corrected)	0.70 [0.66-0.74] (0.67)	0.70 [0.65 – 0.76]	0.72 [0.66 – 0.78] (0.69)	0.71 [0.68 – 0.74] (0.69)

Table 1. Multivariate analysis and discrimination of 30-day unplanned readmission or mortality models.

Conclusion

- External validation demonstrated good calibration of the OPERA model on the US study population.
- Discrimination of those at low risk versus those at high risk remains modest, even upon refitting the model, implying a need for better predictors of poor outcome within 30 days after discharge.