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Readmission Risk Based on Debility and Psychosocial Measures: The Western 9 Algorithm

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Abstract. Many studies have stressed the importance of psychosocial determinants of health such as food insecurity, housing instability, and education level, as important drivers of health outcomes. Western Health developed a set of nine screening questions (the Western 9) based on psychosocial measures to profile patients enrolled in the HealthLinks Chronic Care initiative. An aggregate score was then converted into a Low, Medium and High risk profiles. The aim of the study was to see if the Western 9 questions added additional discriminative power to existing risk of readmission algorithms. Results show that the inclusion of the risk profiles significantly improved model fit and calibration compared to a baseline risk model. Suggestions for further refinement include developing weighted indices for the Western 9 to improve model fit.

Keywords. Readmission risk, social determinants of health, chronic disease, statistical modelling

1. Introduction

Many studies have stressed the importance of psycho-social determinants of health such as food insecurity, housing instability, and education level, as important drivers of health outcomes [1]. However, few studies have examined whether the addition of these determinants into risk prediction models improves risk prediction accuracy, especially for culturally and linguistically diverse groups. Prior studies have incorporated few indicators of social risk or were conducted in small, single-center populations [2]. Adding another level of risk stratification over existing models could allow health systems and clinicians to more accurately identify high-risk groups for targeted interventions and avoid exacerbating disparities in care.

The Victorian Department of Health and Human Services (DHHS) established HealthLinks: Chronic Care (HealthLinks). A funding model designed to remove the funding barriers to delivering alternate models of integrated care for this highly complex

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patient group. It commenced on the 1st of July 2016 and ran for three years to the 30th of June 2019.

As part of their intervention model of care for the HealthLinks initiative Western Health employed a set of 9 questions ("the Western 9") to stratify an eligible HealthLinks patient's risk of readmission based on their debility and psychosocial risk factors. Depending on the response to these questions, patients were stratified into either the High, Medium or Low Risk care group which dictated the level care provided.

This study examined whether the social determinants of health as measured by the Western 9 led to a more coordinated model of care and would be suitable for inclusion into the existing algorithm.

2. Methods

Western Health in consultation with a wider forum of health services, developed a set of nine questions to assess the risk of readmission to hospital in parallel with the DHHS algorithm. The aim was to see if the Western 9 questions were suitable to further profile patients at risk of readmission. By design, the questions focused more on the psychosocial aspects of a patient's perceived health state. Table 1 lists the questions for each patient. If patients scored 3 or more, they were assessed as being in the *High* risk group, if they have a score of 2 they are classed as *Medium* risk and a score of one or less as *Low* risk. A total of 518 patients were subsequently assessed and consisted of 175 High risks, 146 Medium risk and 197 Low risk.

Table 1. Debility, psychosocial screening question for Western Health (The Western 9).

Question
1. Does the patient experience difficulty walking (e.g., unable to walk 5 metres in 5 seconds), or had a slip, trip or fall in the past 6-months?
2. Does the patient have memory problems or confusion?
3. Is the patient being treated for anxiety, depression or other mental illness?
4. Will the patient experience any homelessness for the month after they leave the hospital?
5. Does the patient have inadequate food available in their home?
6. Does the patient have inadequate heating and cooling in their home?
7. Will the patient experience difficulty caring for themselves or have inadequate carer support for the 30 days after they leave hospital?
8. Does the patient or carer believe the patient might unexpectedly return back to a hospital bed in the 30 days after they leave the hospital?
9. Do you (Navigator) believe the patient might unexpectedly return back to an inpatient bed in the 30 days after the patient leaves the hospital?

To assess how well the risk groups developed for the Western 9 questions predicted readmission risk they were included in a logistic regression model using patient hospital admission data that was the basis for analysis in the main evaluation of Healthlinks. Variables used in the model were Age (included as a natural spline with 5, 10, 20, 40, 60, 80, 90 and 95% quantiles), Sex, SEIFA IRSAD decile (Index of Relative Socio-

Economic Advantage and Disadvantage), Smoking status, Marital status, and number of primary diagnoses at admission (as a cubic spline with three degrees of freedom).

Readmission in 30 days,binomial(0,1) ~Risk group+Age+Sex+Number of diagnoses+SEIFA decile+Smoking status+Marital status

We assessed model fit and performance in two ways: first, we compared the calibration curves of the Risk Group model to the base model; and second, we compared the Risk Group model to the base model using likelihood ratio tests.

3. Results

The addition of a Risk group category to the base risk model signifcantly improved the model fit ($p<0.02$). The odds of readmission to hospital within 30 days of discharge were significantly higher if you were in the High risk group compared to the Low risk group. However there was no significant difference in the odds of readmission if you were in the Medium risk group compared to the Low risk group (Table 2).

Table 2. Odds ratios and 95% confidence intervals for risk of readmission in 30 days by Western 9 risk group categories.

Risk Group	Odds Ratio (95% confidence interval)
Low	1(reference)
Medium	0.83(0.5-1.4)
High	1.7(1.0-2.7)

The addition of Risk Group to the base model resulted in mixed results for model calibration (Figure 1). Whilst there is little difference at low probabilities of readmission the Risk model overestimate actual risk whilst the base model underestimated the risk of readmission. To assess potential differences in predictive power for individual questions a principal component analysis was undertaken. A matrix consisting of the Western 9 responses for particpants plus a dummy variable for readmission in 30 days was used.

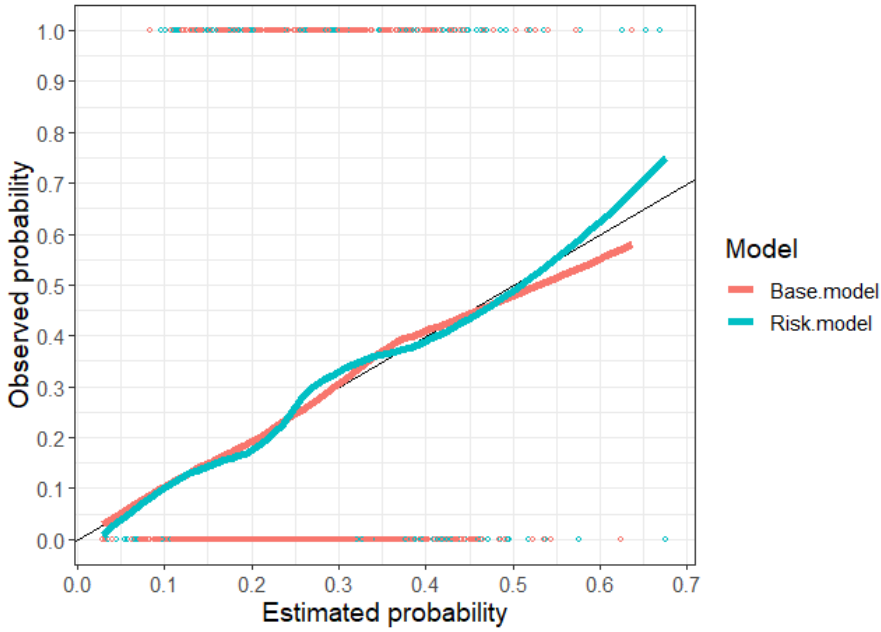

Figure 1 Calibration curve comparing the base model with the model with added risk model.

Figure 2 plots the first two principal components. The label RA30 represents the readmission in 30 days dummy variable. There were very weak correlation between individual questions and RA30. Patient Return (Q8). Navigator return (Q9) and Carer (Q7) are weakly positively correlated with the RA30 variable. Housing (Q4), Food (Q5) and Heat/cool (Q6) are slightly negatively correlated with RA30. Walking(Q1), Mental health (Q3) and Memory (Q2) seem to be uncorrelated with RA30.

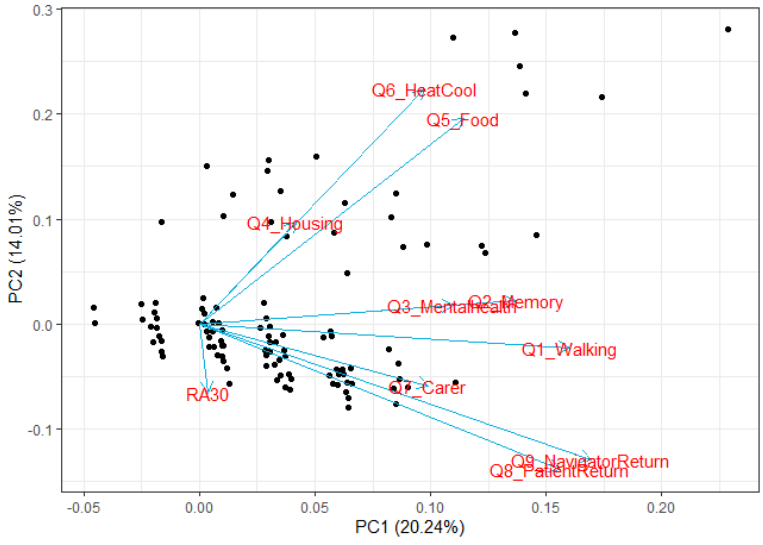

Figure 2. Principal component plot of Western 9 questions and readmission in 30 days.

4. Discussion

The addition of psychosocial and debility measures to current readmission risk models for complex care patients significantly enhanced their discriminative ability, as has been shown in other studies [2-4]. Limited literature focusses on these types of determinants, with most employing hospital and local government administrative data such as race, marital status, income and education as the main predictors [e.g. 2]. Others use measures such as antidepressant scripts to measure depression and anxiety indirectly [5].

The Western 9 scoring system for risk stratifying patients has the potential to better stream patients into appropriate care pathways. When broken down into the individual questions those that focus on the patient, navigator or carers perceptions of returning to hospital and the patient's ability to care for themselves are most positively correlated with the risk of readmission. Counterintuitively questions concerned with social deprivation measures such as risk of homelessness and lack of adequate heating/cooling and food in the home seem negatively associated with risk of readmission. This may be the result of very few positive answers to these questions. The patient's degree of mobility, memory problems and anxieties do not add to the risk of readmission. A limitation of this study is that intervention intensity based on risk group which may dilute the hypothesised effect of risk group. A parallel study using the same questions with no intervention is currently underway. This will further test the validity of the Western 9.

5. Conclusions

The inclusion of psycho-social measures within a risk of readmission model increases its discriminative ability, especially for patient centered factors. The Western 9 scoring system has the potential to better stream patients into more suitable care, however further research is required to further validate the findings from this study.

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