HEALTH POLICY ANALYSIS

Update on the Charlson and Elixhauser conditions as predictors of 12-month mortality

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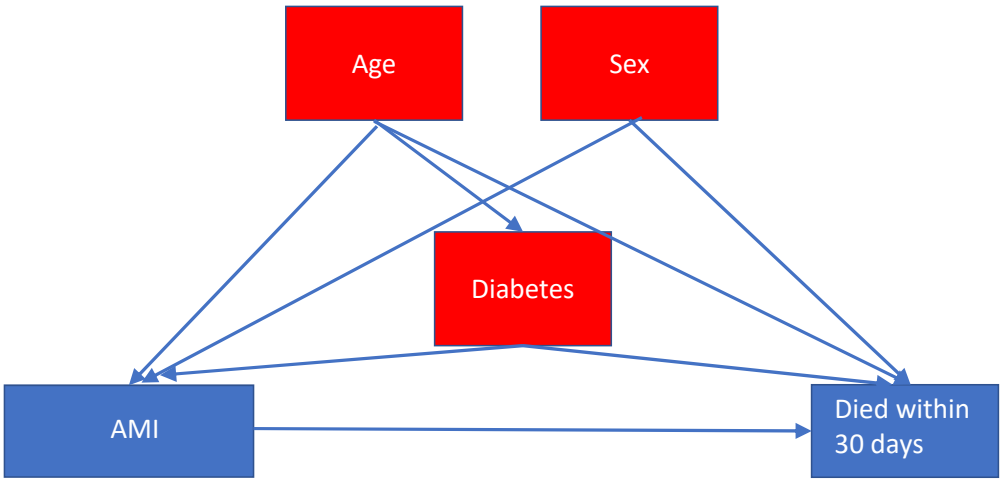
Introduction

- **The Charlson[1] Comorbidity Index (CCI) and Elixhauser[2] conditions are widely used to reduce bias in the statistical analysis of data from observational studies.**
- **In their review in 2022, Charlson and Wells stated, "the number of citations of the original version of the CCI exceeds 36,925".[3]**
- **The Charlson and Wells review also stated that the CCI is often considered the gold standard measure to assess comorbidity in clinical research.**
- **In Australia, the Charlson index informs hospital pricing adjustments for complications and readmissions.**
- **However, the index's transferability to different populations - both geographically and over time is debated.**

[1] Charlson et al. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*, *40*(5), 373-383.
[2] Elixhauser et al. (1998). Comorbidity measures for use with administrative data. *Med Care*, *36*(1), 8-27.
[3] Charlson and Wells (2022). Comorbidity: From a confounder in longitudinal clinical research to the main issue in population management. Psychother Psychosom ; 91(3): 145–151

Aside

- **When is it necessary to adjust for covariates when using observational data to imply causation?**



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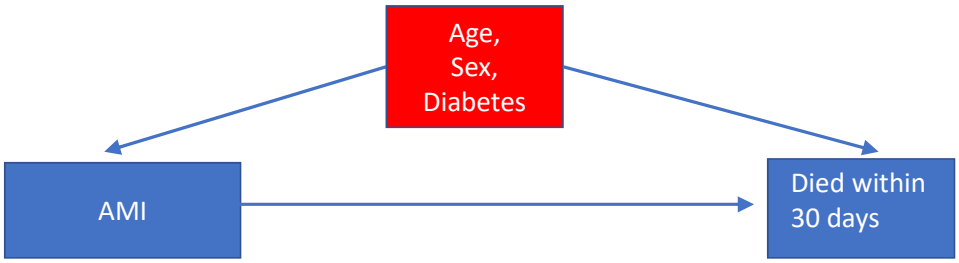

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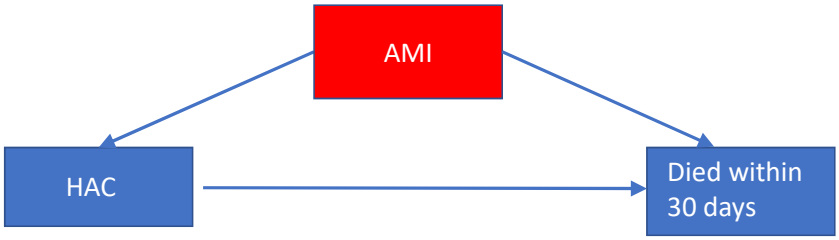
- **When is it necessary to adjust for co-morbidity when using administrative data to imply causation?**



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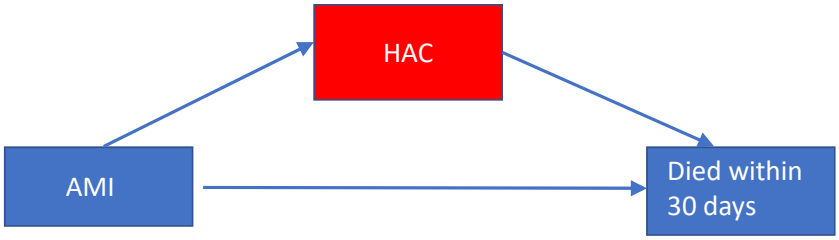

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Charlson index

- Developed as a prognostic measure to increase the pool of patients eligible for clinical trials.
- Developed using data for **559/604** sequential patients in a single hospital in 1984.
- The research team manually extracted information from medical records.
- A list of 30 medical conditions were considered for inclusion in the index.
- Outcome was risk of death within 12 months from admission to hospital.
- Estimates of risk were obtained from a Proportional Hazards model with age as the only covariate.
- Estimates of relative risk (RR) were used to obtain the weights for the index
  - 11 conditions were excluded because the estimate of increased risk was <20%.
  - 19 conditions were included, and index values were derived from the RR values. Values <3.5 were rounded to the nearest integer and values >= 3.5 were allocated 6.
  - Has been modified over time and the version used here has 17 conditions
- The index was validated in a sample of **685** patients with breast cancer at a single hospital – admitted between 1962 to 1969.

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Elixhauser conditions

- Developed for administrative purposes (using hospital administrative data) – to predict hospital charges, length of stay, and within hospital mortality.
- Developed using all nonmaternal hospital admissions (in California in 1992) for patients aged 18+, who were not discharged to a long-term care facility or another hospital.
- Included **1.78** million patients from 438 hospitals.
- Comorbidity was defined as a clinical condition that existed before admission, was not related to the principal diagnosis, and was likely to have a significant impact on mortality and costs.
- Odds ratios were obtained from a logistic regression model that included each of the conditions and the covariates of age, race, gender, expected primary payer, emergency admission, surgical patient, and presence of a hospital acquired complication.
- Elixhauser et al. recommended against using their results to create an index, but others[1,2] have created one.

[1] var Walraven et al. (2009). A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data.
[2] Thompson et al. (1998). A new Elixhauser-based comorbidity summary measure to predict in-hospital mortality.

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Aim

Use routinely collected data from an Australian study to:

- Determine if the weights allocated to the Charlson Comorbidity Index are still appropriate today.
- Compare the predictive performance of the conditions included in the Charlson Comorbidity Index and the Elixhauser conditions for 12-month mortality
- Examine their predictive performance for 12-month readmission and hospital acquired complications (HACs).

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Method (data)

- Data source is a linked dataset established for the evaluation of the HCH trial (October 2017 to 30 June 2021). The data:
  - Was obtained for all financial years from 2015-16 to 2021-22.
  - Contains demographic characteristics of participants linked to all hospital admissions and deaths. Linkage was done by the Australian Institute of Health and Welfare.
  - Contains records for **11,159** patients enrolled in the trial and a random sample of **over 3 million** patients from the same 10 PHN where the HCH patients attended their practice.
  - Restricted for this analysis to the **199,667** patients who were discharged alive after an overnight hospital stay for an acute event in the 2015-16 financial year.

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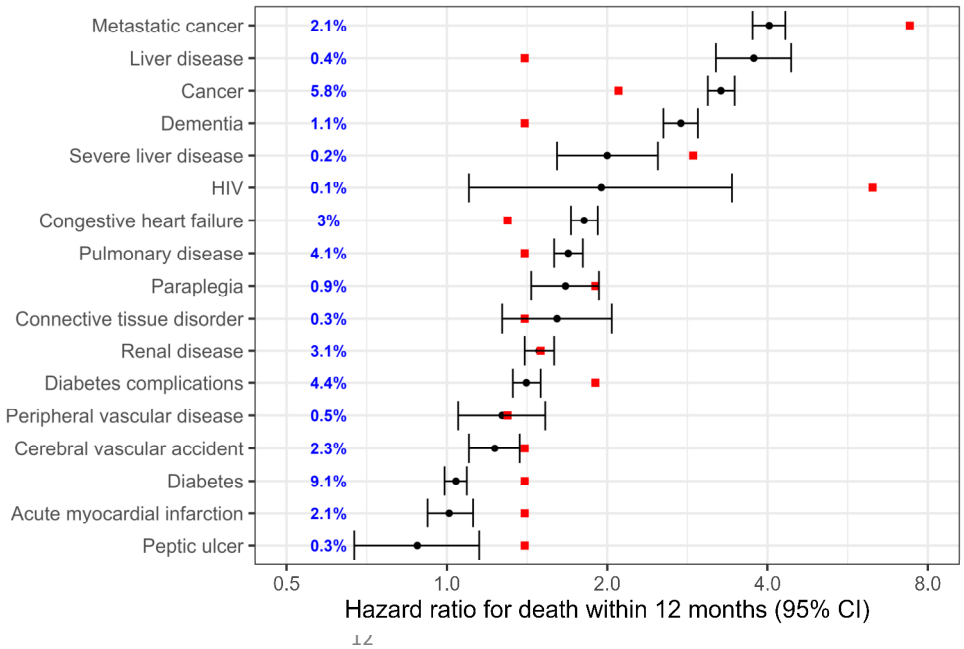
Method (analysis)

- Using the ICD-10-AM codes developed by **Sundararajan et al.[1],** we searched the discharge diagnoses and classified each person's first admission during that year as having or not having each of the Charlson conditions.
- Elixhauser conditions were based on the codes presented in **Quan et al[2]**.
- The predictive ability of the different classifications was tested using logistic regression (rather than PH models).
- Area under the receiver characteristic curve (AUC) was used to measure predictive performance.
- Models were fit using the following 3 outcomes of 1 year mortality, 1 year readmission and HAC using patients index admission

[1] Sundararajan et al. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality.
[2] Quan et al. Coding algorithms and defining comorbidities in ICD-9-CM and ICD10 administrative data.

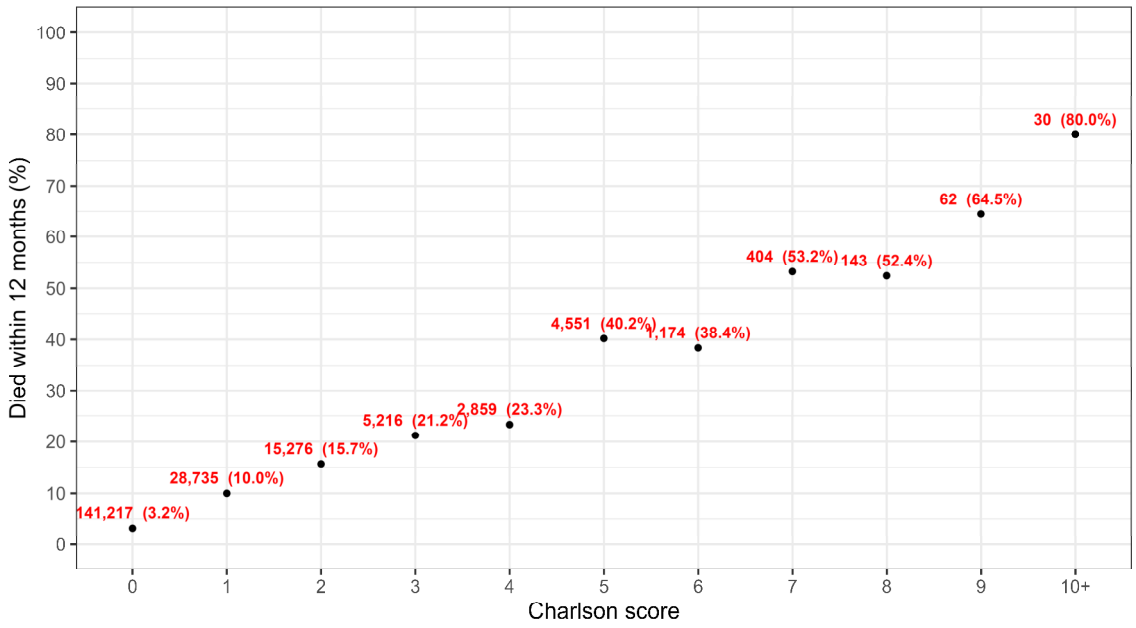
Results (Charlson conditions)

- Black dot and whiskers are HRs from our data
- **Percentages in blue are the prevalences of the condition in our data**
- Red squares are HRs from the Charlson Comorbidity Index



Results (Charlson index)

Number of people and the percentage who died



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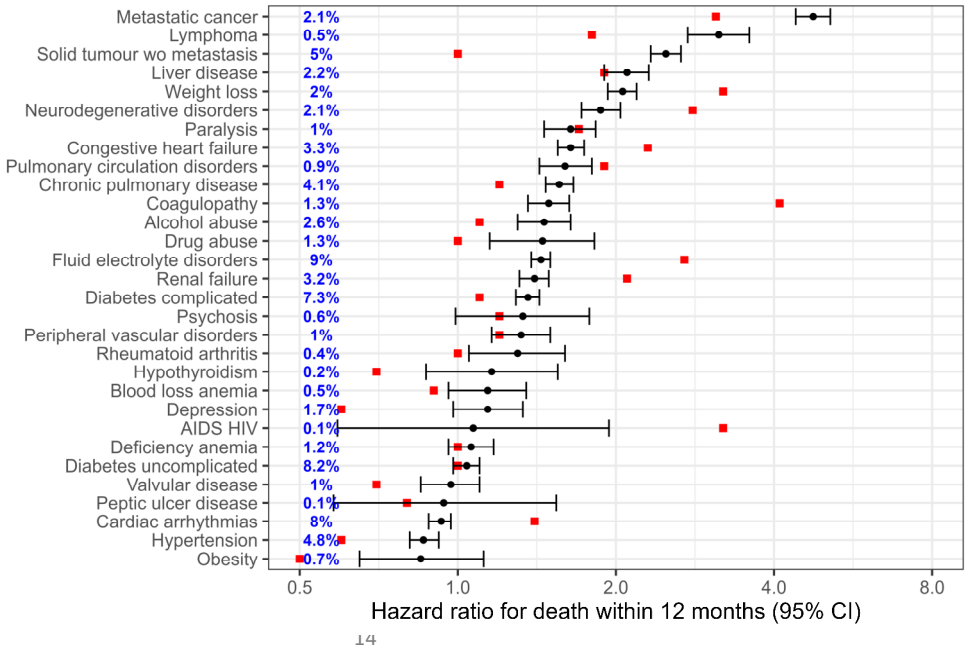
Results (Elixhauser conditions)

- Black dot and whiskers are HRs from our data
- **Percentages in blue are the prevalences of the condition in our data**
- Red squares are HRs from the Elixhauser paper



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Results (comparison)

- **Performance of models to predict 12-month mortality:**
  - Age and sex only (AUC = 0.804).
  - Charlson score only (AUC = 0.737)
  - Conditions included in the Charlson score only (AUC = 0.747).
  - Age, sex and conditions including in the Charlson score (AUC = 0.868)
  - Age, sex and Elixhauser conditions (AUC = 0.878)

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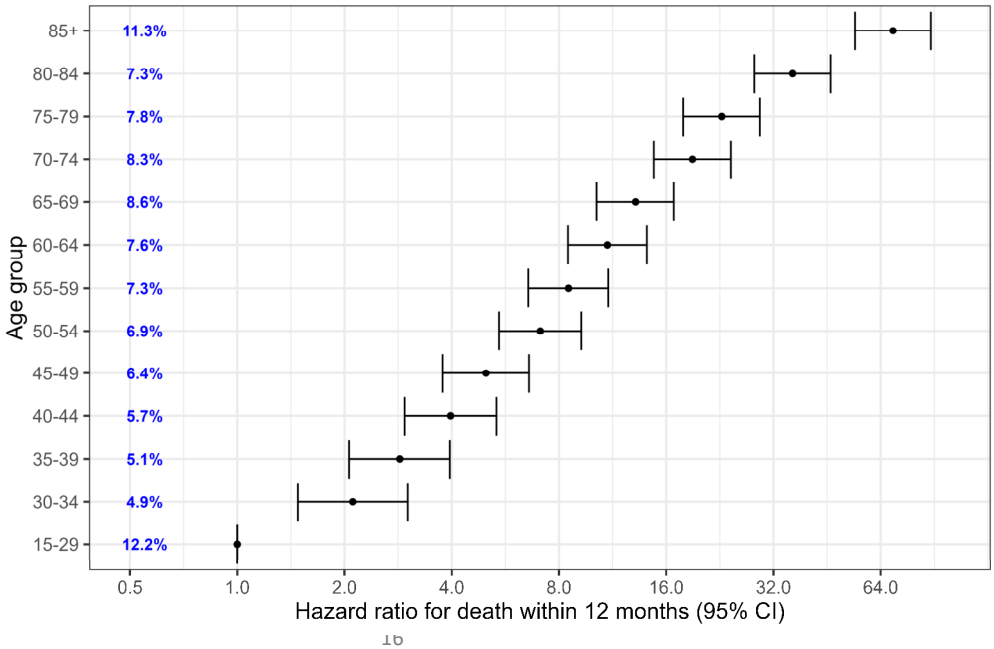
Results (Age group)

- Black dot and whiskers are HRs from our data
- **Percentages in blue are the prevalences of the condition in our data**



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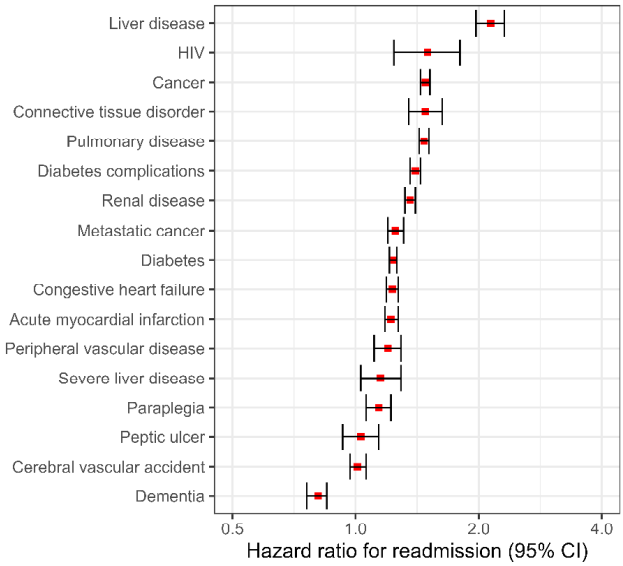
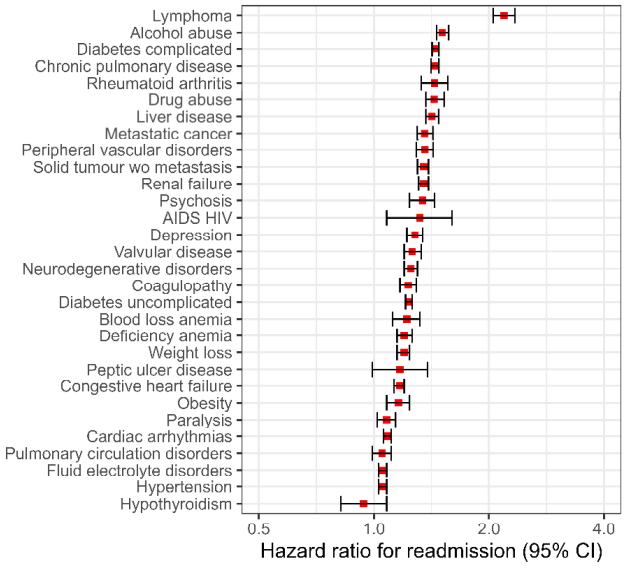
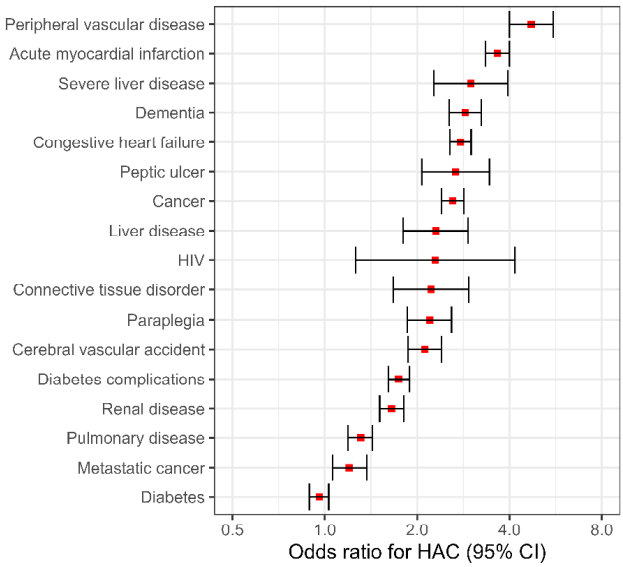
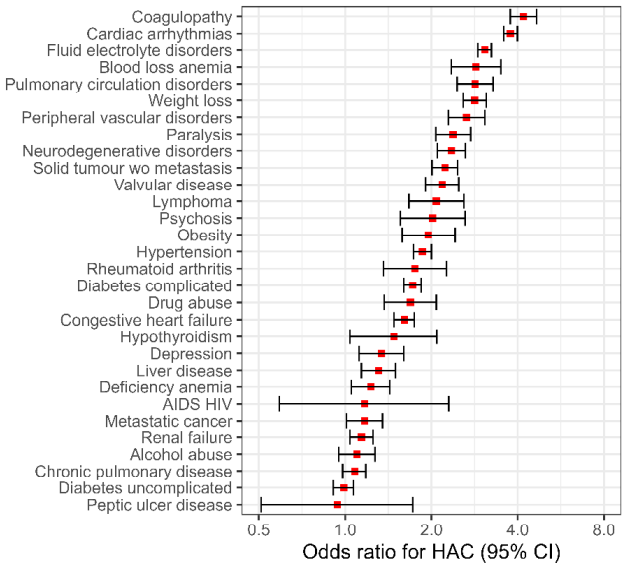
Results (Readmission)





Results (HACs)





AUC Charlson: 0.749; AUC Elixhauser: 0.830

Conclusion

- **The Charlson Index is a strong predictor of death within 12 months - with the risk increasing as the score increases**
- **Weights used to create the index should be updated for the Australian setting**
- **Charlson conditions are better predictors of mortality than the index**
- **Elixhauser conditions perform slightly better than the Charlson conditions (in these data)**

- **When adjusting for co-morbidity, consider using directed acyclical graphs (DAGs) to determine whether it is necessary to adjust for confounders**

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Thank you

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