Mixture Distribution Item Response Theory (IRT) as a Method for Identifying Clinically Relevant Subgroups of Patients

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Objective

Present Mixture Distribution Item Response Theory (IRT) as a novel method to identify latent classes of patients based on their full spectrum of medical information and extract salient group-specific diagnoses.

Background

- Patient populations are heterogeneous and complex
- Accurate clinical groupings can help clinicians better manage care by identifying who may benefit from interventions that are tailored to their specific needs
- Traditional methods often use clusters of few conditions to characterize complexity without reference to the full health profile while IRT uses full spectrum of medical information
- Mixture Distribution IRT identifies distinct latent subgroups of patients from patterns of coexisting medical and psychological conditions

Methods

Sample

- Random sample of 67,181 Veterans Health Administration (VHA) patients at high risk of hospitalization in 1 year
- High-risk defined by Care Assessment Needs (CAN-2-H) scores with probability of hospitalization ≥ 0.25 (~90th percentile) at any time during 2014

Analyses: Mixture-distribution IRT models

- Empirically identified latent patient subgroups based on patterns of 31 mental and physical health diagnoses (ICD-9 codes)

Results

- Five latent subgroups identified from physical- and mental-health diagnoses (see bar chart)
- 15 of the original 31 diagnoses had enough variability and sufficient fit to include in final models
- 9 of the 15 diagnoses were sufficient to define subgroups
- Final model fit well for 87% of patients (N_{final}=58,275)

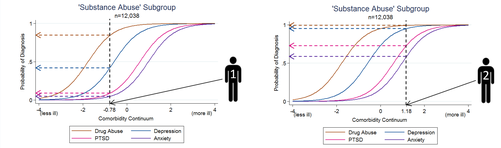
How to Read IRT Graphs

Case 1

- Person comorbidity estimate* = -0.78
- Likely (pr > 0.5) to have Drug Abuse
- Unlikely (pr < 0.5) to have others

Case 2

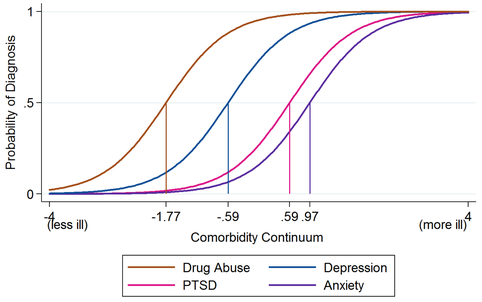
- Person comorbidity estimate = +1.18
- Likely (pr > 0.5) to have all diagnoses



*Person and diagnoses placed on same continuum.

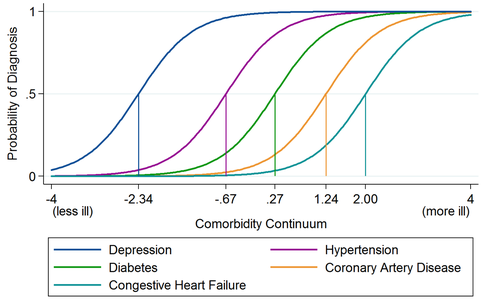
"Substance Abuse" Subgroup

n=12,038; 94% men



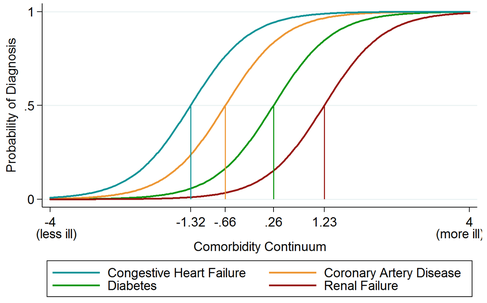
"Complex Mental Health" Subgroup

n=12,088; 85% men



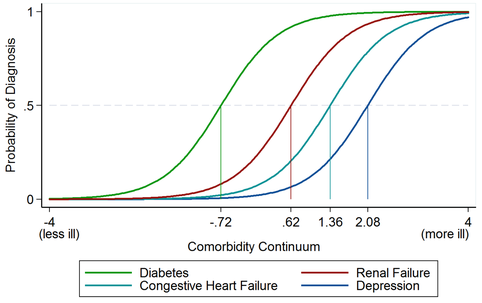
"Cardiac" Subgroup

n=9,259; 98% men



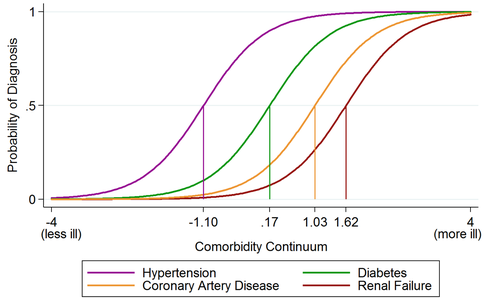
"Complex Diabetes" Subgroup

n=15,908; 96% men

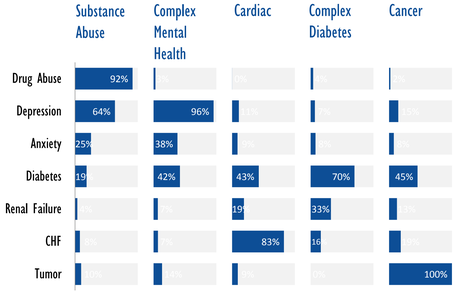


"Cancer" Subgroup

n=8,981; 97% men



Select Diagnoses by Subgroup



Limitations

- Comprehensiveness and accuracy of diagnoses are limited in electronic records
- Only 31 diagnoses available and 16 were too infrequent in sample to use; more diagnoses or full risk sample may produce more subgroups or change the nature of existing groups

Conclusions

- IRT modeling of coexisting medical/psychological condition patterns enables identification of coherent subgroups that may not be apparent yet clinically important
- IRT offers a way to characterize complicated patients into subgroups that could facilitate care management of complex patients

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