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-24) 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)

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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Select Diagnoses by Subgroup

Substance Abuse Complex Mental Health Cardiac Complex Diabetes Cancer

Drug Abuse

Depression

Bipolar

Diabetes

Nephritis

Gastrointestinal

Renal Failure

Tumor

Cardiac

Complex Mental Health

Cardiac

Complex Mental Health

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