Validation of the Combined Comorbidity Score in the ICD-10 Era: Application to High-Risk Populations

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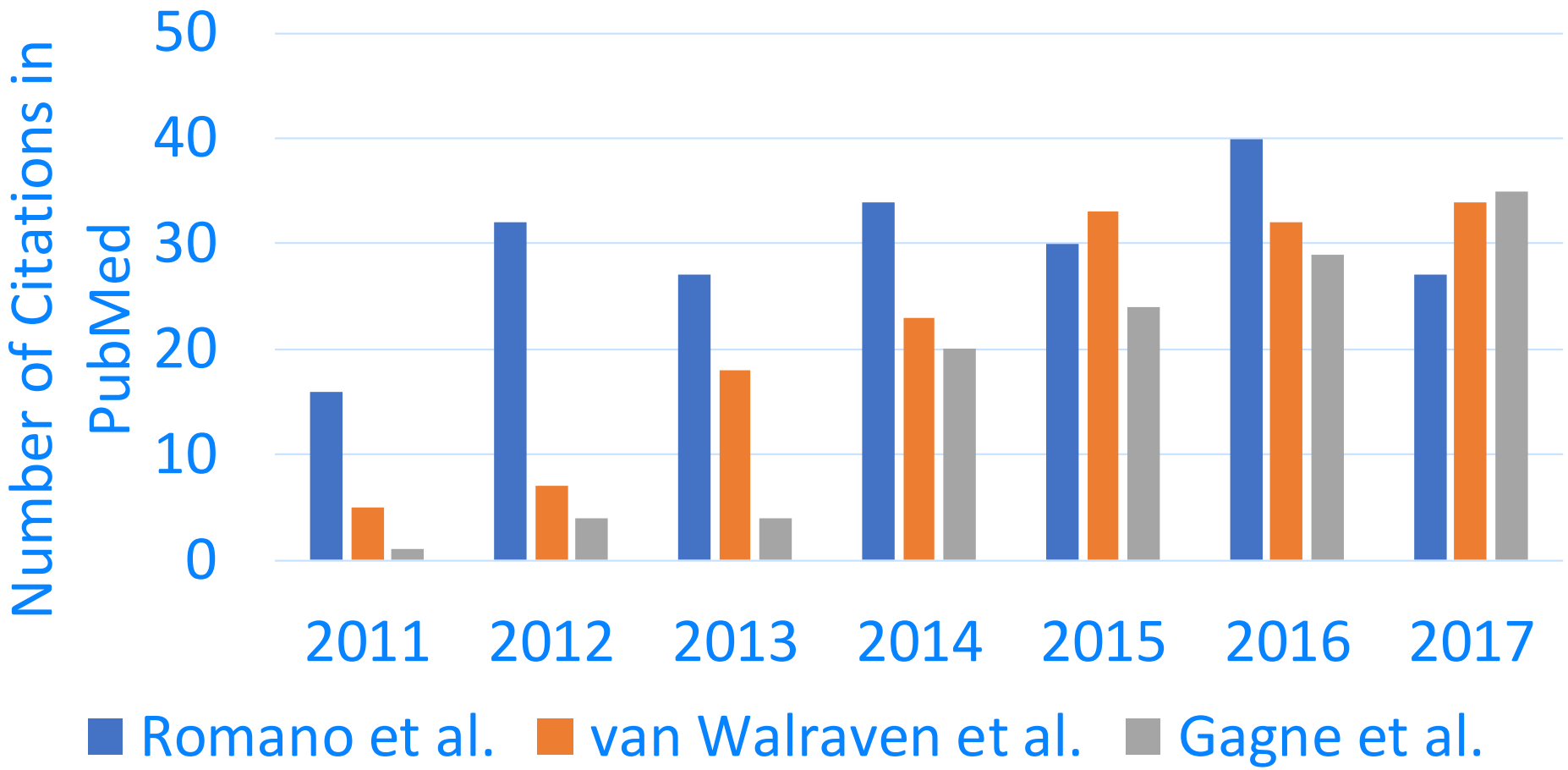
Background

- In October 2015, U.S. transitioned to the 10th Revision of the International Classification of Diseases, Clinical Modification (ICD-10-CM)
  - General Equivalence Mappings (GEMs) developed by Center for Medicare & Medicaid Services
- Researchers must adapt diagnosis and procedure-based variable definitions
- Which mapping strategy will yield best possible confounding control?

Prior validation of ICD-10-CM-based CCIs

- In 2017, Sun et al.[1] validated four ICD-10-CM adaptations of the Charlson-Elixhauser Combined Comorbidity Index (CCI)
  - GEMs simple backward mapping (SBM)
  - GEMs forward-backward mapping (FBM)
  - Canadian mapping proposed by Quan et al.[2] (CA)
  - All three above mappings combined (ALL)
- Combined approach best discriminated between those re-hospitalized within 30-days and those not re-hospitalized
  - Only ICD-10-CM data from Jan. – Mar. 2016 available at time of study

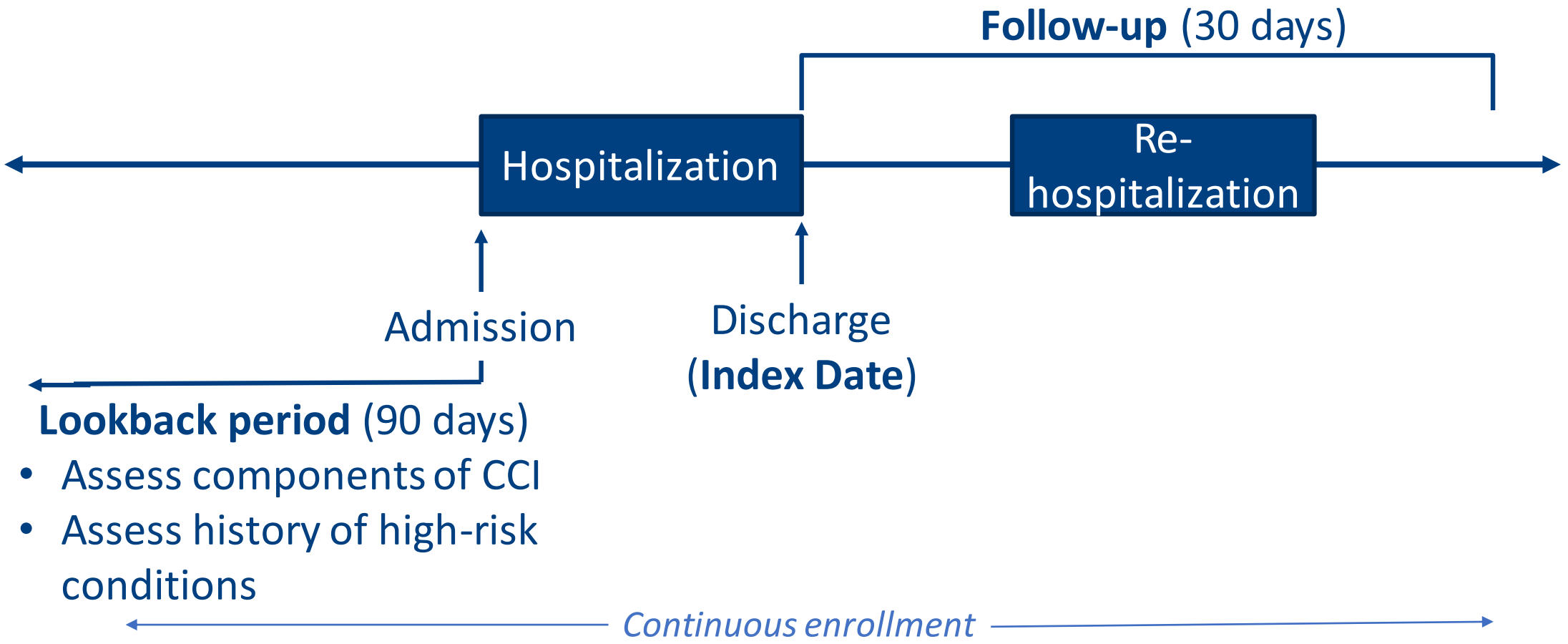
The rise of the combined comorbidity index



Objectives

- Validate CCI as predictor of re-hospitalization in ICD-10-CM era
  - Using additional data through 2017
- Assess in commonly-studied, high-risk populations
  - Atrial fibrillation
  - Irritable bowel disease
  - Type 2 diabetes mellitus
- Sensitivity analysis
  - Vary lookback & follow-up periods: 30, 90, 183 days

Study design & data source



Data source: Truven Health MarketScan® Research Databases

Cohort identification:

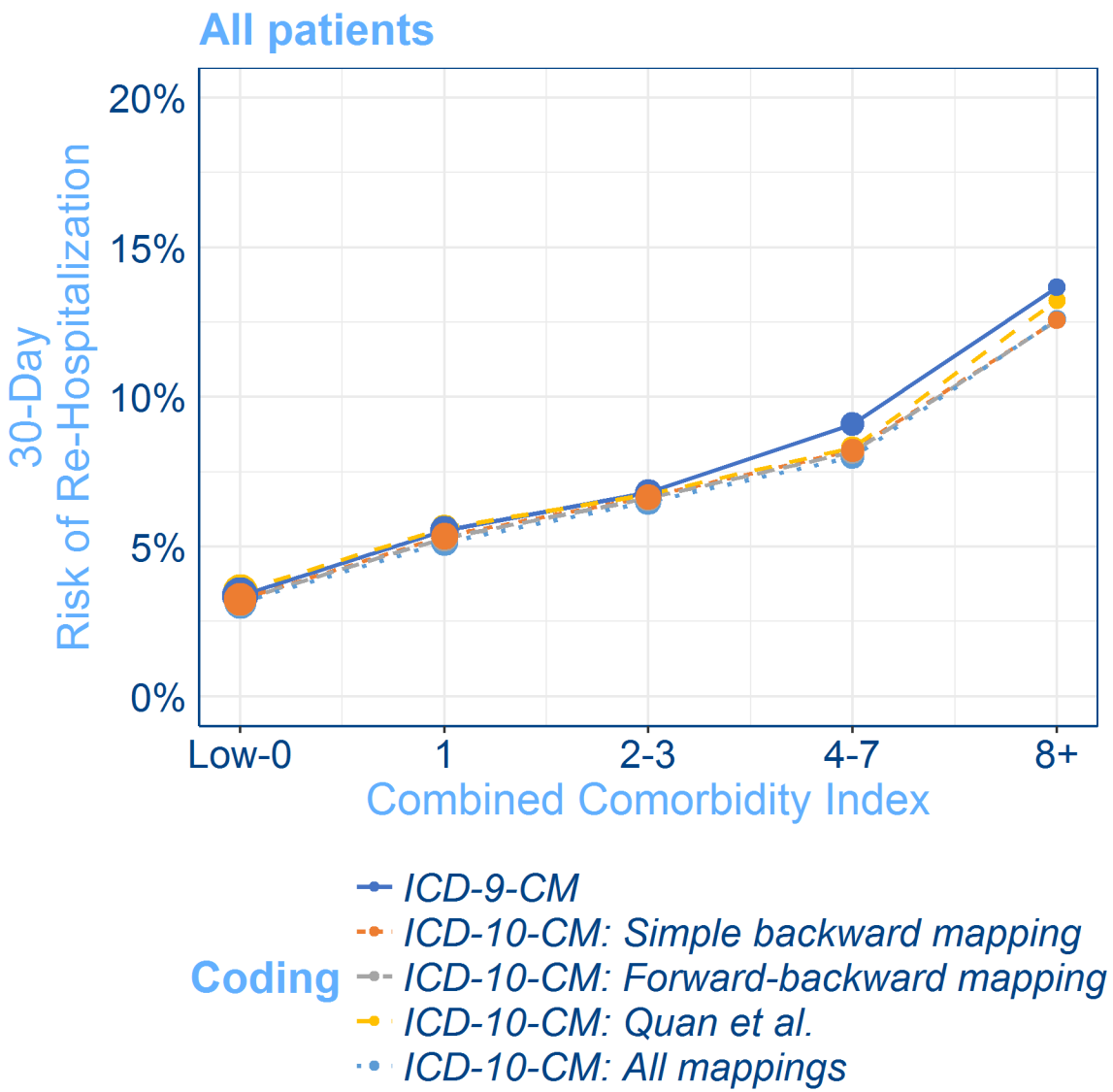
Apr 2014 – Sep 2015 (ICD-9-CM)

Oct 2015 – Mar 2017 (ICD-10-CM)

Association with re-hospitalization

Baseline characteristics

	ICD-9-CM	ICD-10-CM
Mean age, years	50.1	50.2
Mean CCI	1.2	1.4 (SBM) 1.5 (FBM) 1.3 (CA) 1.6 (ALL)

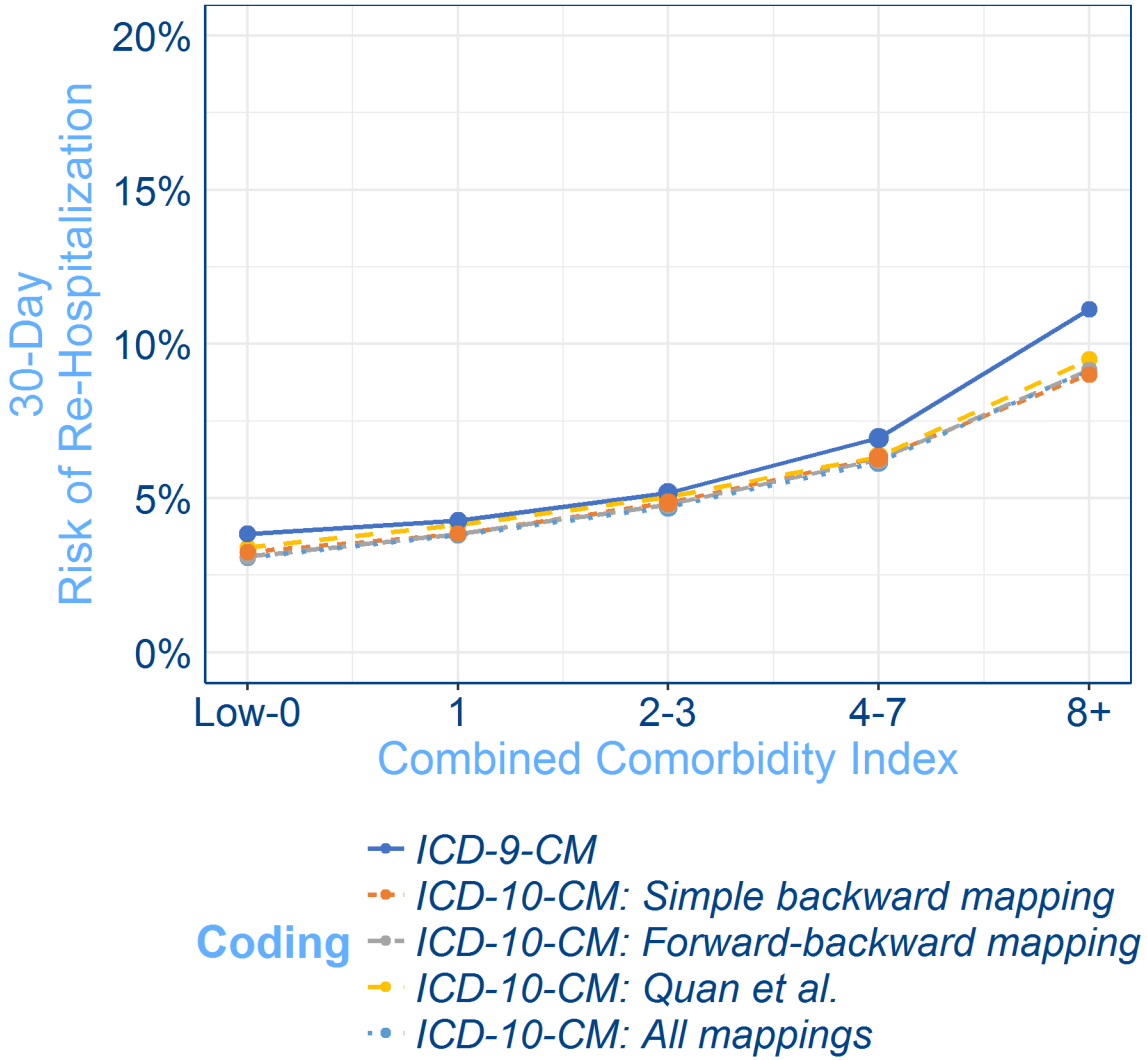


Association with re-hospitalization

Baseline characteristics

	ICD-9-CM	ICD-10-CM
Mean age, years	74.2	74.6
Mean CCI	3.4	3.8 (SBM) 3.9 (FBM) 3.5 (CA) 4.0 (ALL)

History of atrial fibrillation

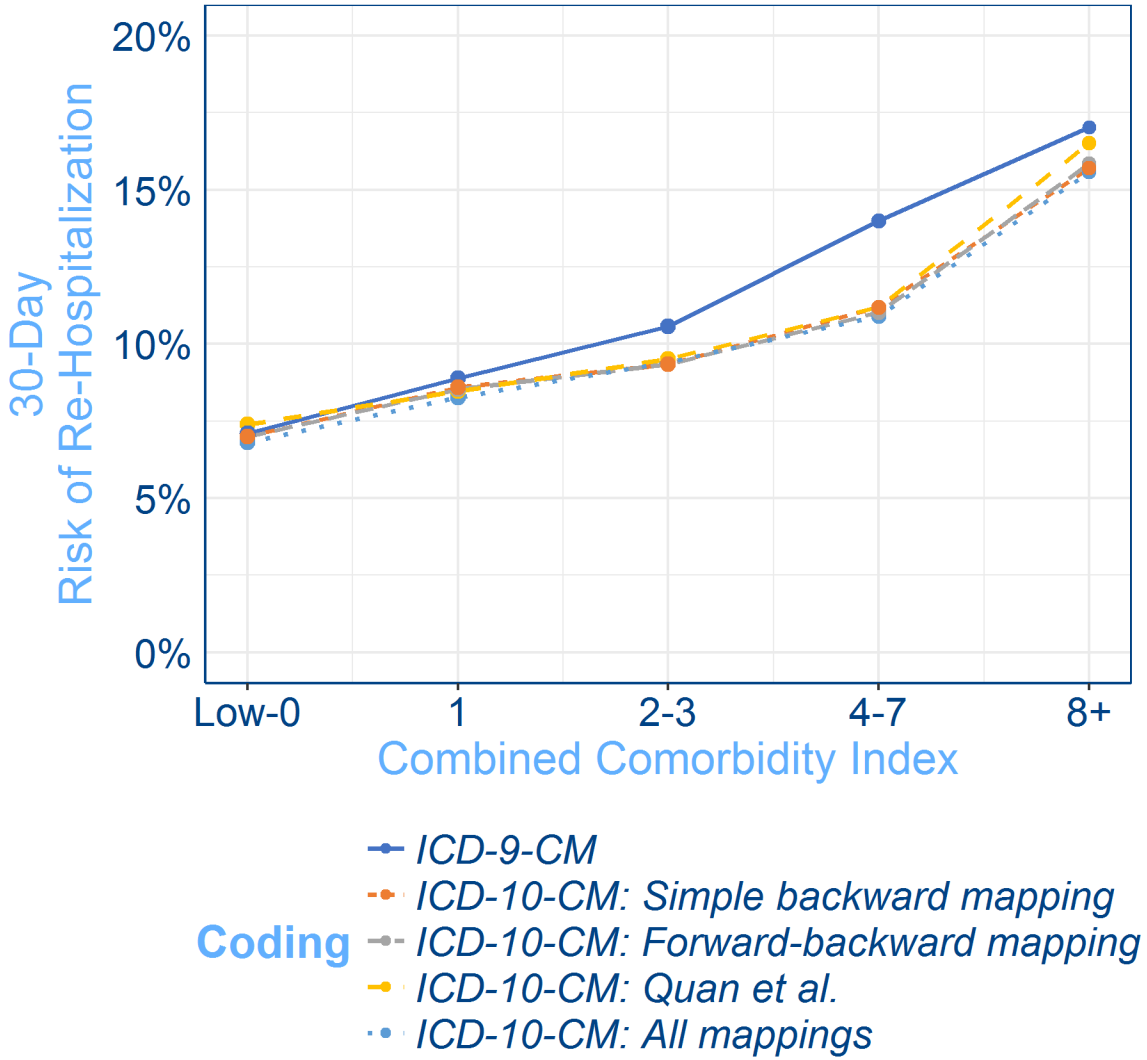


Association with re-hospitalization

Baseline characteristics

	ICD-9-CM	ICD-10-CM
Mean age, years	50.1	50.7
Mean CCI	1.4	1.7 (SBM) 1.8 (FBM) 1.5 (CA) 2.0 (ALL)

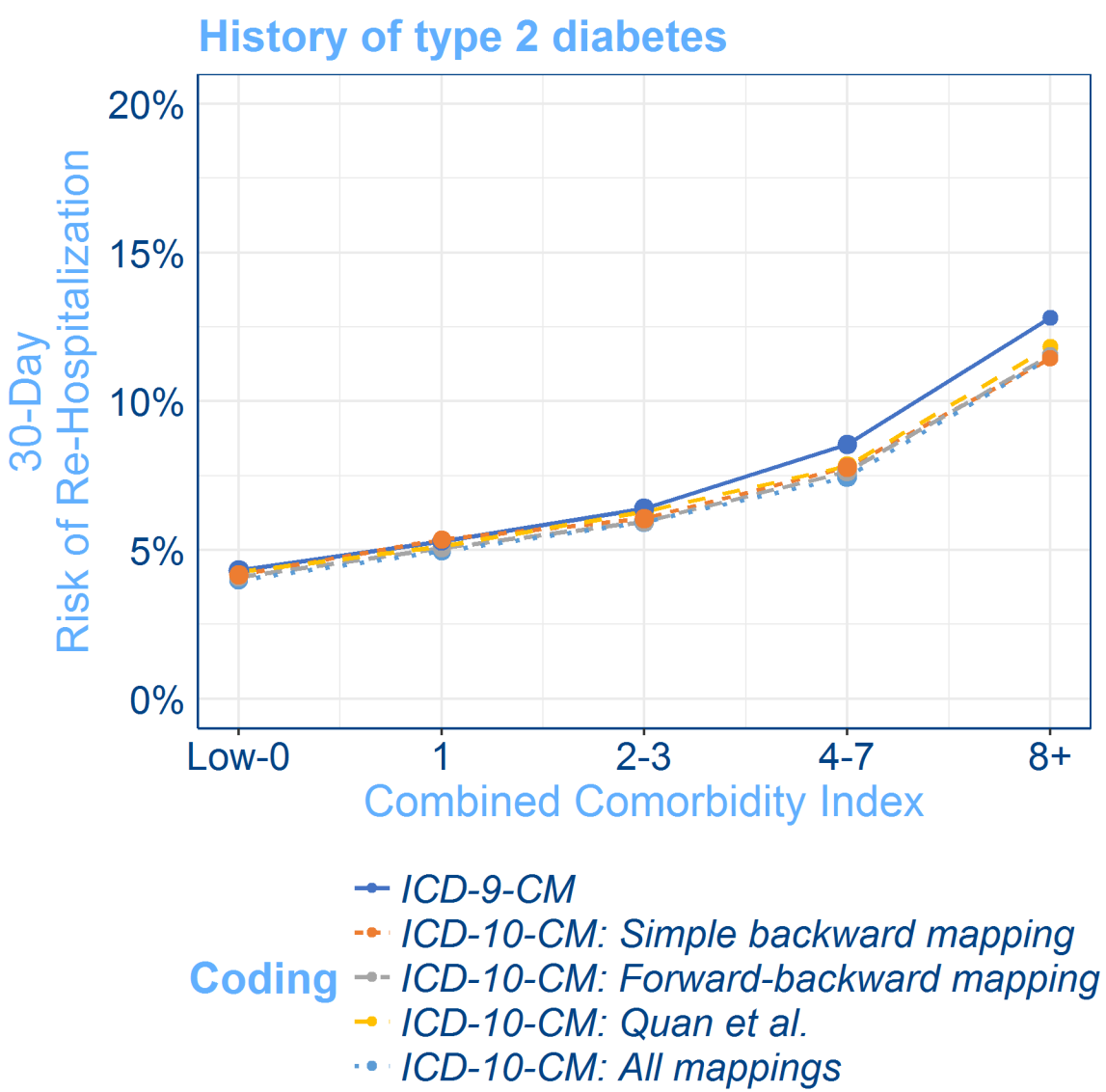
History of irritable bowel disease



Association with re-hospitalization

Baseline characteristics

	ICD-9-CM	ICD-10-CM
Mean age, years	63.9	64.7
Mean CCI	2.1	2.6 (SBM) 2.8 (FBM) 2.5 (CA) 3.0 (ALL)

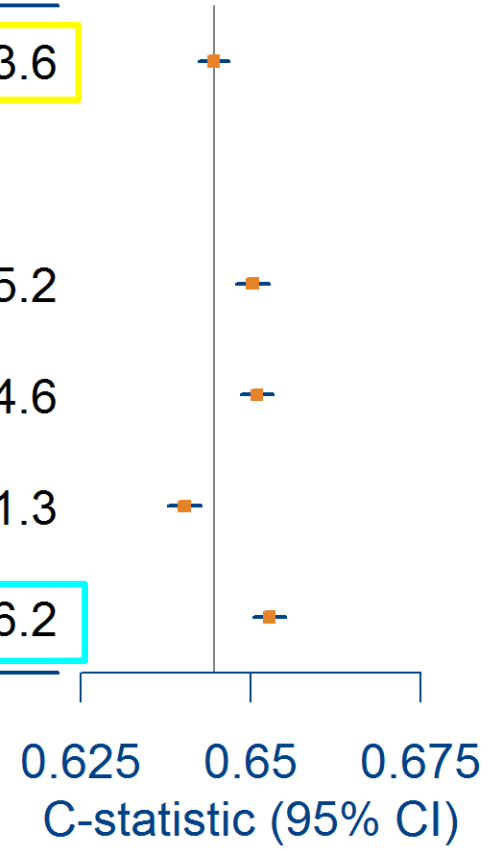


Discrimination & calibration in ICD-10 era

All patients

Coding	No. Events (%)	C-Stat. (95% CI)	H-L Stat.
ICD-9-CM	74,161 (5.2)	0.645 (0.642, 0.647)	1,613.6
ICD-10-CM			
Simple backward mapping	59,075 (5.2)	0.65 (0.648, 0.653)	1,405.2
Forward-backward mapping	59,075 (5.2)	0.651 (0.649, 0.653)	1,344.6
Quan et al.	59,075 (5.2)	0.64 (0.638, 0.643)	1,991.3
All mappings	59,075 (5.2)	0.653 (0.65, 0.655)	1,326.2

*Critical χ^2 values for the Hosmer-Lemeshow test are 15.5 ($p < 0.05$), 20.1 ($p < 0.01$), and 26.1 ($p < 0.001$)

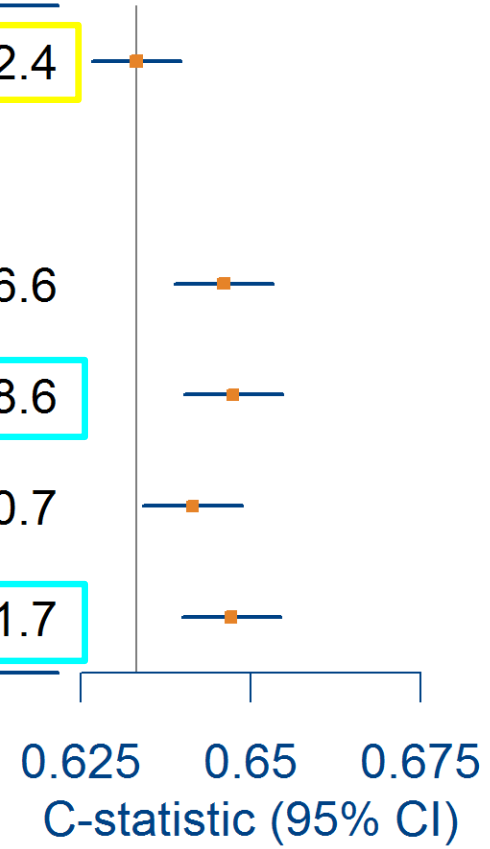


Discrimination & calibration in ICD-10 era

History of atrial fibrillation

Coding	No. Events (%)	C-Stat. (95% CI)	H-L Stat.
ICD-9-CM	7,914 (6)	0.633 (0.627, 0.64)	52.4
ICD-10-CM			
Simple backward mapping	6,272 (5.6)	0.646 (0.639, 0.653)	66.6
Forward-backward mapping	6,272 (5.6)	0.647 (0.64, 0.655)	68.6
Quan et al.	6,272 (5.6)	0.641 (0.634, 0.649)	70.7
All mappings	6,272 (5.6)	0.647 (0.64, 0.654)	71.7

*Critical χ^2 values for the Hosmer-Lemeshow test are 15.5 ($p < 0.05$), 20.1 ($p < 0.01$), and 26.1 ($p < 0.001$)

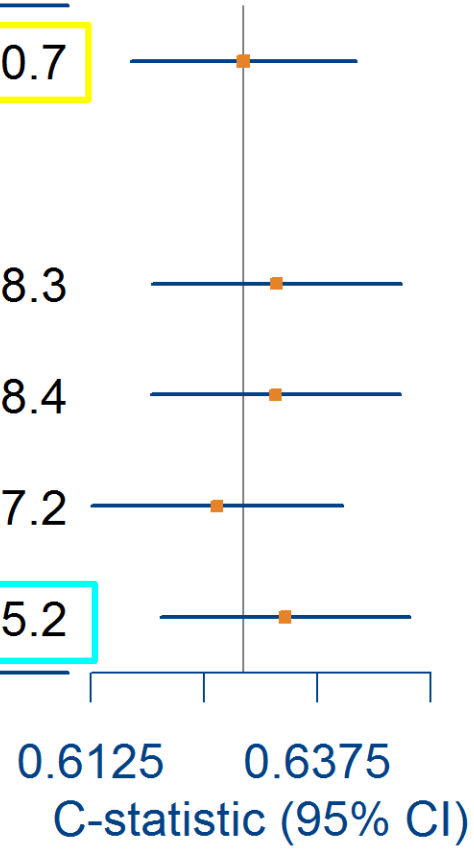


Discrimination & calibration in ICD-10 era

History of irritable bowel disease

Coding	No. Events (%)	C-Stat. (95% CI)	H-L Stat.
ICD-9-CM	2,125 (9.3)	0.629 (0.617, 0.642)	10.7
ICD-10-CM			
Simple backward mapping	1,635 (8.8)	0.633 (0.619, 0.647)	8.3
Forward-backward mapping	1,635 (8.8)	0.633 (0.619, 0.647)	8.4
Quan et al.	1,635 (8.8)	0.626 (0.613, 0.64)	17.2
All mappings	1,635 (8.8)	0.634 (0.62, 0.648)	5.2

*Critical χ^2 values for the Hosmer-Lemeshow test are 15.5 ($p < 0.05$), 20.1 ($p < 0.01$), and 26.1 ($p < 0.001$)

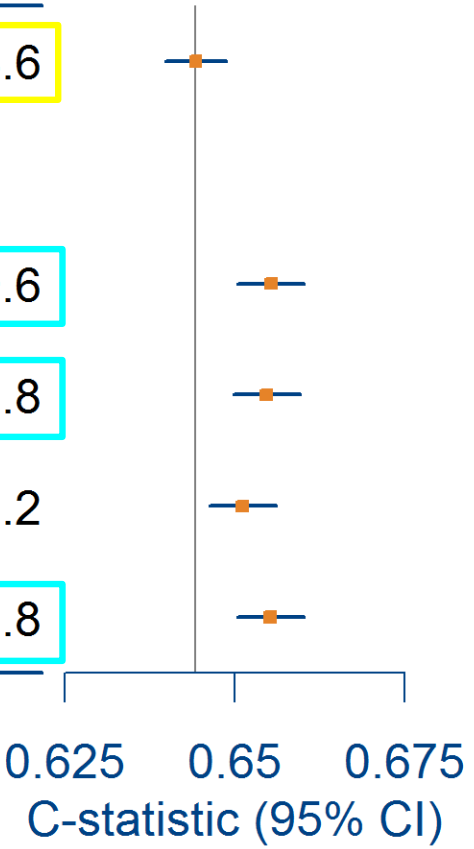


Discrimination & calibration in ICD-10 era

History of type 2 diabetes

Coding	No. Events (%)	C-Stat. (95% CI)	H-L Stat.
ICD-9-CM	16,098 (6.3)	0.644 (0.64, 0.649)	144.6
ICD-10-CM			
Simple backward mapping	13,088 (6.2)	0.655 (0.65, 0.66)	129.6
Forward-backward mapping	13,088 (6.2)	0.655 (0.65, 0.66)	101.8
Quan et al.	13,088 (6.2)	0.651 (0.646, 0.656)	112.2
All mappings	13,088 (6.2)	0.655 (0.65, 0.66)	81.8

*Critical χ^2 values for the Hosmer-Lemeshow test are 15.5 ($p < 0.05$), 20.1 ($p < 0.01$), and 26.1 ($p < 0.001$)



Limitations

- Lack of mortality data
  - CCI initially validated as mortality predictor
- Discrimination & calibration ≠ confounding control
  - Empirical comparative safety and effectiveness examples needed
- Still early in use of ICD-10-CM
  - Future may bring validated ICD-10-CM algorithms for all CCI components

Conclusions

- Replication and extension of work by Sun et al.
  - More ICD-10-CM experience, different commercial data population
- Combined mapping approach yields best discrimination in majority of settings
  - Robust to changes in lookback and follow-up duration
  - Calibration results equivocal

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