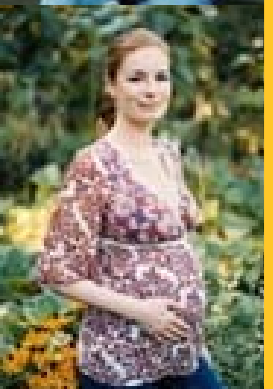

High Cost Claim Prediction for Actuarial Applications

Vincent Kane, FSA, MAAA

Research Scientist, DxCG- A Division of Urix Inc.

The Second National Predictive Modeling Summit

Washington, D.C.

September 22, 2008

Predictive Modeling vs. Risk Adjustment

- PM: Predict claims $ or stratify risk for people or groups, by any means necessary
  - Uses detailed claim-based diagnosis information and possibly procedure data, utilization data, prior costs, timing of claims, benefit provisions, lifestyle-based variables or HRA data, credit info, kitchen sink
- RA: Quantify differences in health status among populations and over time to discover illness burden
  - Picks up on differences in health status and health status alone. Risk *assessment* characterizes the relative cost differences for persons or groups, for example, using relative risk factors.

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Choice of a predictive model versus risk adjuster

- If risk-adjusting payments to providers or plans, you may not want to include prior utilization, costs or procedures.
  - Fairly assess health status, therefore, ignore diagnosis codes that are vague, difficult to audit, and gameable.
- For underwriting, care management, and stop loss or reinsurance applications, you may want to use all available predictors
  - Could recalibrate standard risk adjustment models by adding new variables, or
  - Build a predictive model from scratch for the intended application

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"High Cost Case Model" (HCCM)

- A predictive model which uses all diagnoses and pharmacy claims to prospectively find members likely to be high cost
- Based on RxGroups® and HCC clinical groupings
  - Adds proprietary variables based on prior year cost and utilization patterns
    - Blood disorders, cancers, CHF, diabetes, usual suspects
    - Extremely high cost drugs, certain injectables, etc.
  - Assumes fully run out claims
  - Does not use a lag before the prediction period

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HCCM - Model Characteristics

- Calibrated w/ Thomson MedStat Marketscan data
- Dependent variable, and therefore outcome to be predicted, are year 2 total allowable claims costs
  - A year 2 risk score is the model output
- Prospective with top coding choices
  - No top coding
  - Top coded at $250k
  - Top coded at $100k
  - Top coded at $25k

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How is HCCM Different From Prospective DCG/HCC Model?

- Uses prior costs and RxGroups® (NDC codes) as inputs
- Higher R-squared (22.1% vs 14.1%)
- Improved predictive ratios
- Performs better in top ½% and 1%
- Has a higher Positive Predictive Value (PPV) for predicting high cost patients

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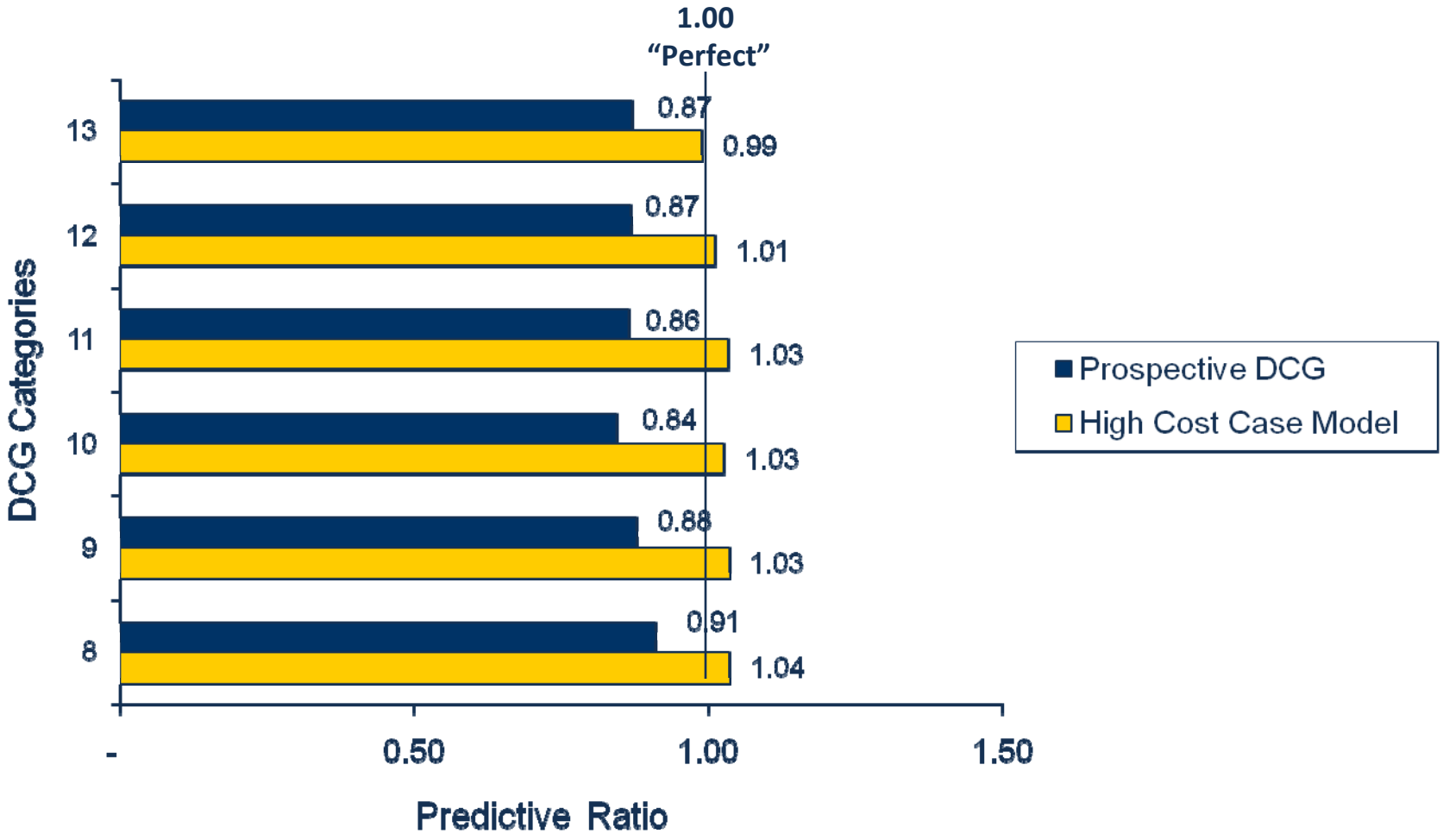
HCCM Performs Better In Low DCG Buckets and …



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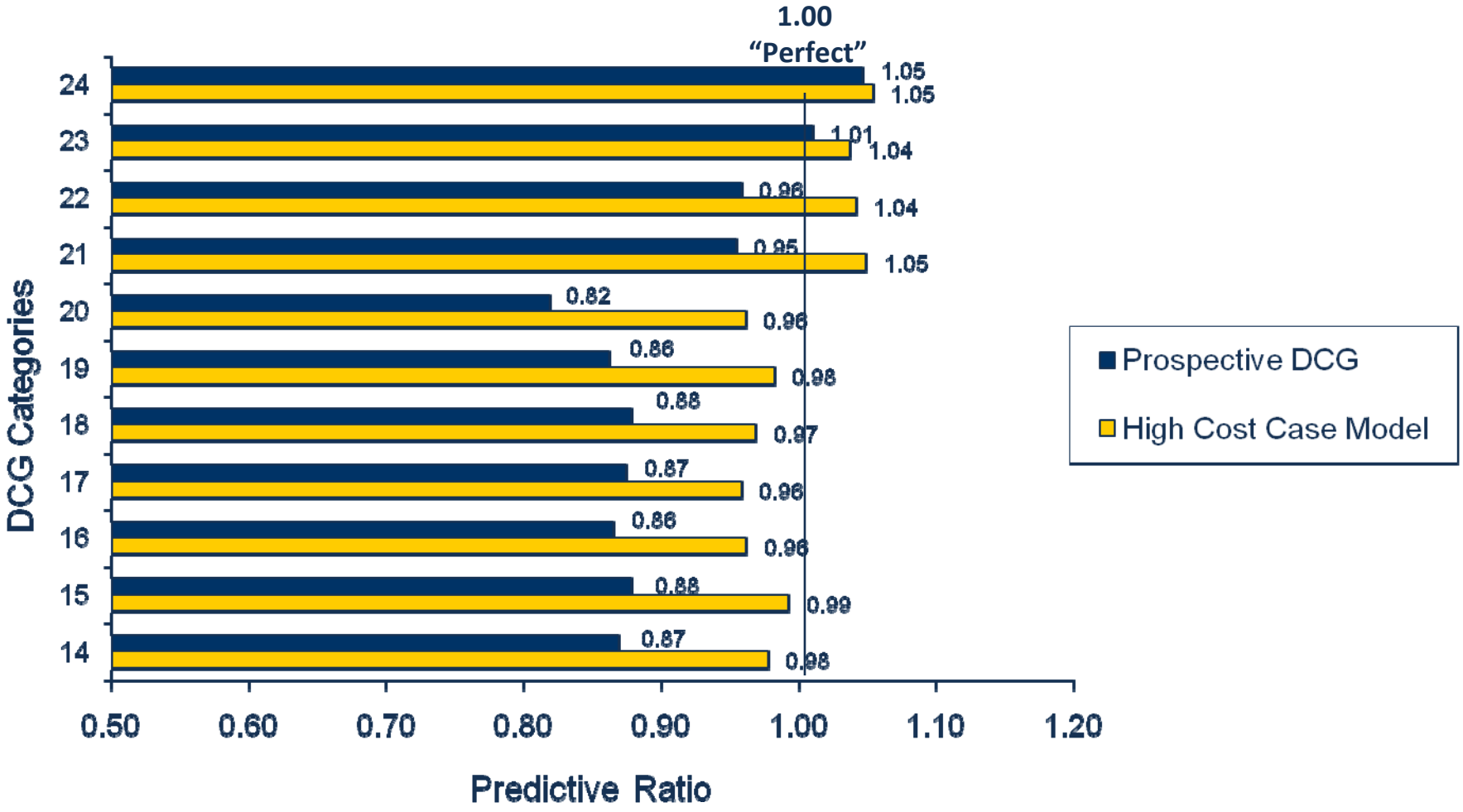
…Performs Much Better In High DCG Buckets



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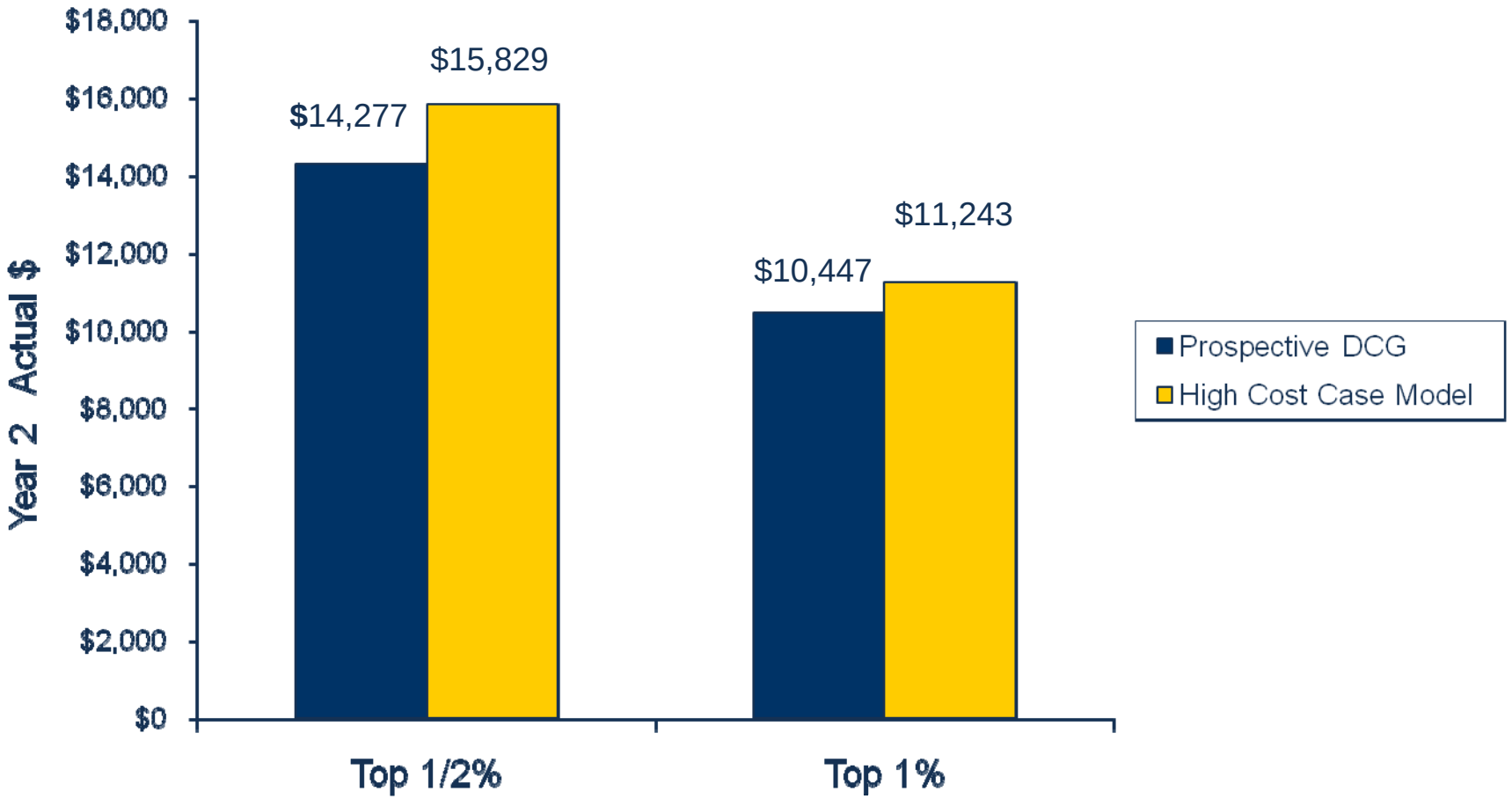
HCCM Finds More Expensive Individuals in Top Groups



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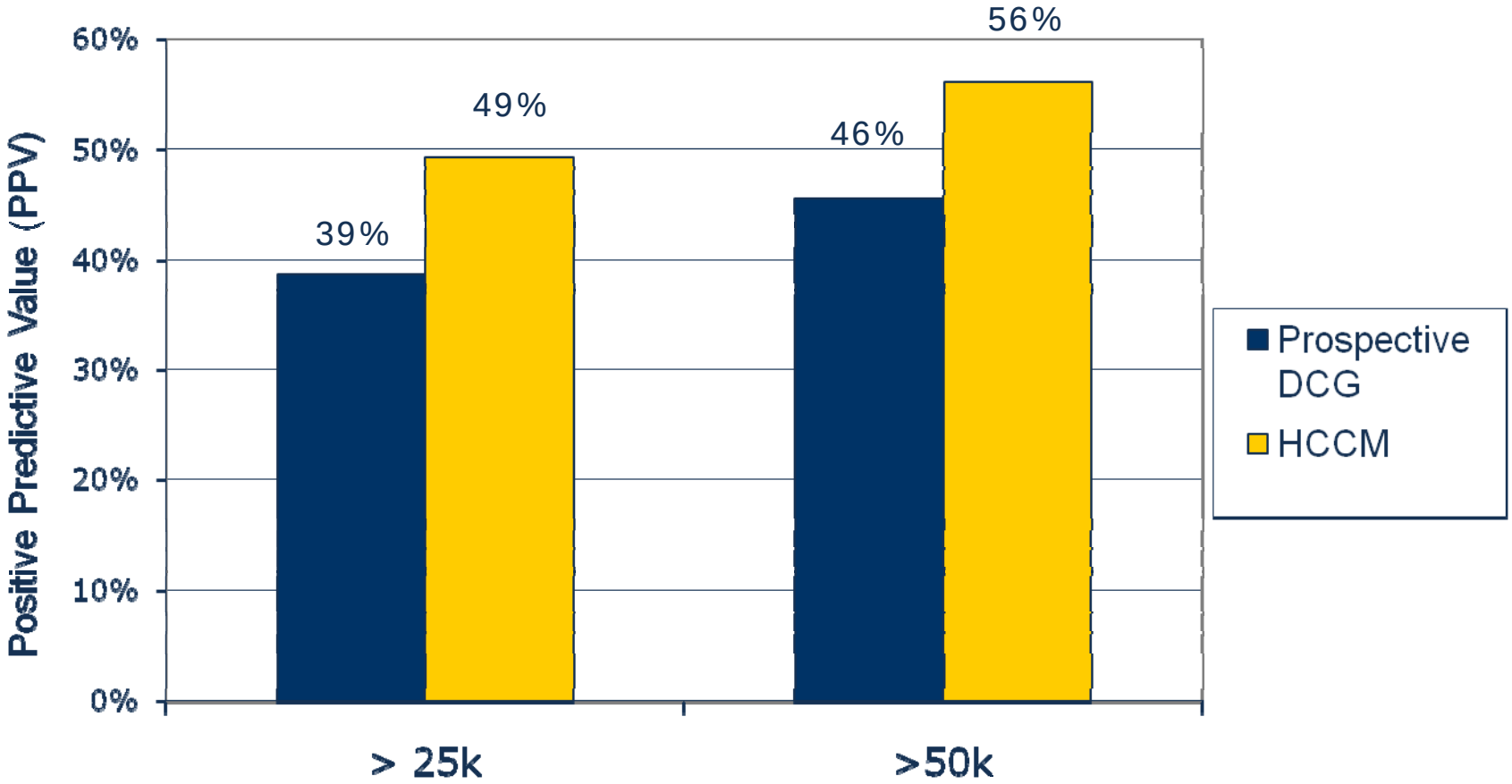
HCCM Correctly Predicts More Expensive Individuals



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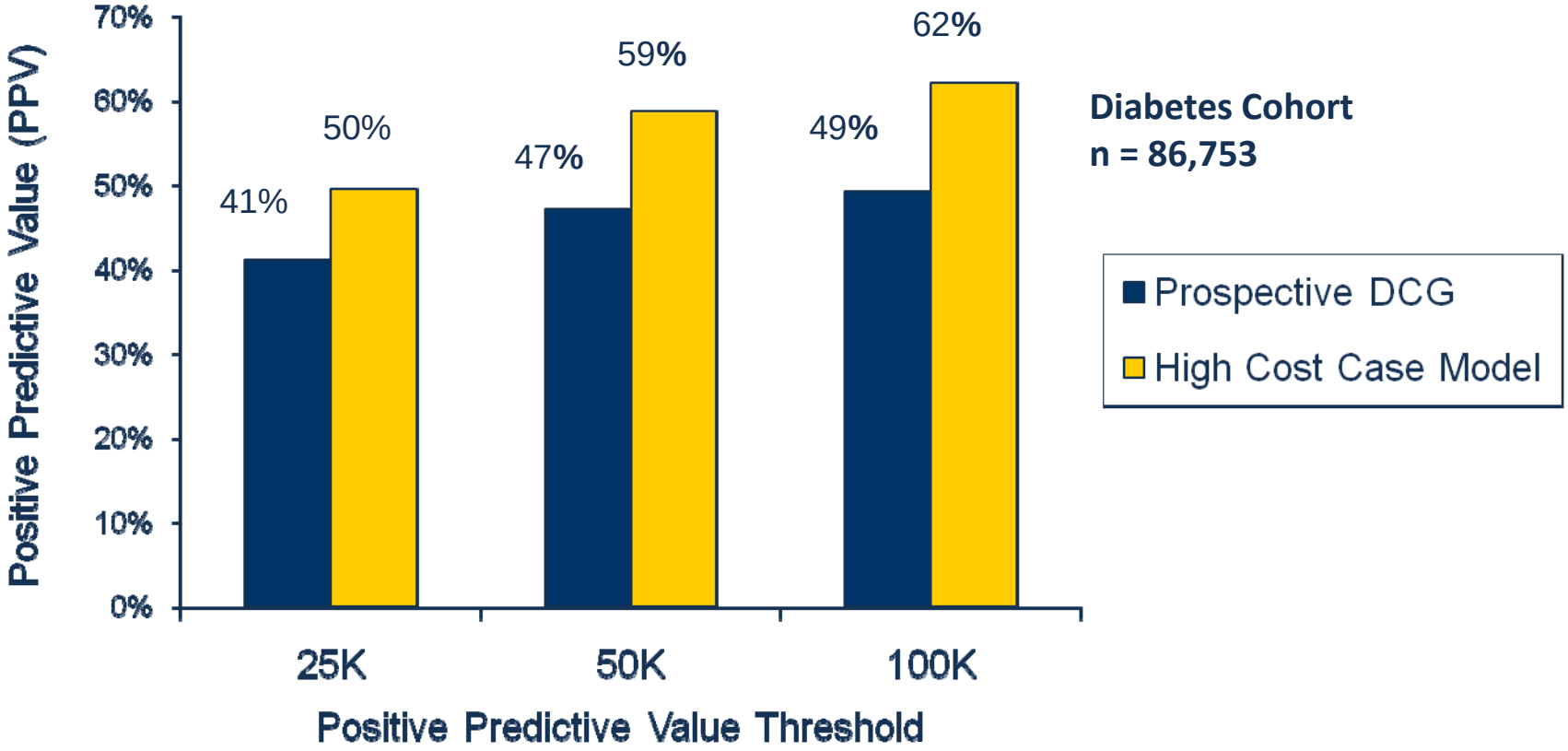
HCCM Correctly "Finds" More Cases – *PPV for Diabetic Cohort*



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Comparing HCCM with Other Means of Predicting Future Costs

- There are lots of different approaches that may be used to predict future costs
  - Age-sex
  - Prior year cost
  - Prospective DCG model
  - Prospective RxGroups model
  - Parametric methods using distributional forms
  - Two-part models
  - Other econometric models
  - Data mining techniques
  - *Combinations of methods*

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Upgrading the standard DCG-HCC model to create one type of "Combined Method"

- In the MarketScan database, DxCG created a model to simulate the combination of the traditional methods
- The recalibration combines age sex categories, the prospective DCG score and year 1 costs to predict year 2 costs
- We define this as the "Combined Method"

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“Predictive Model” performance versus standard diagnosis-based risk adjusters

	R-Squared
Prospective DCG	14.1%
Combined Method (Prospective DCG and Prior Costs)	16.5%
HCCM (no top coding)	22.1%

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Predictive performance improves with decreasing top-coding thresholds

High Cost Case Model	R-squared
No Top Coding	22.1%
$ 250k	26.6%
$ 100K	28.8%
$ 25K	31.4%

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Also possible to create “top groups” for each model

- Top groups using the prospective DCG model
  - Members who were in the top ½ percent using the prospective DCG method (N= 12,727)
  - Members who were in the top 1 percent using the prospective DCG method (N= 25,453)
- Top groups using the combined method
  - Members who were in the top ½ percent using the combined method (N= 12,727)
  - Members who were in the top 1 percent using the combined method (N= 25,453)
- Top groups using HCCM (no top coding)
  - Members who were in the top ½ percent using HCCM (N= 12,727)
  - Members who were in the top 1 percent using HCCM (N= 25,453)

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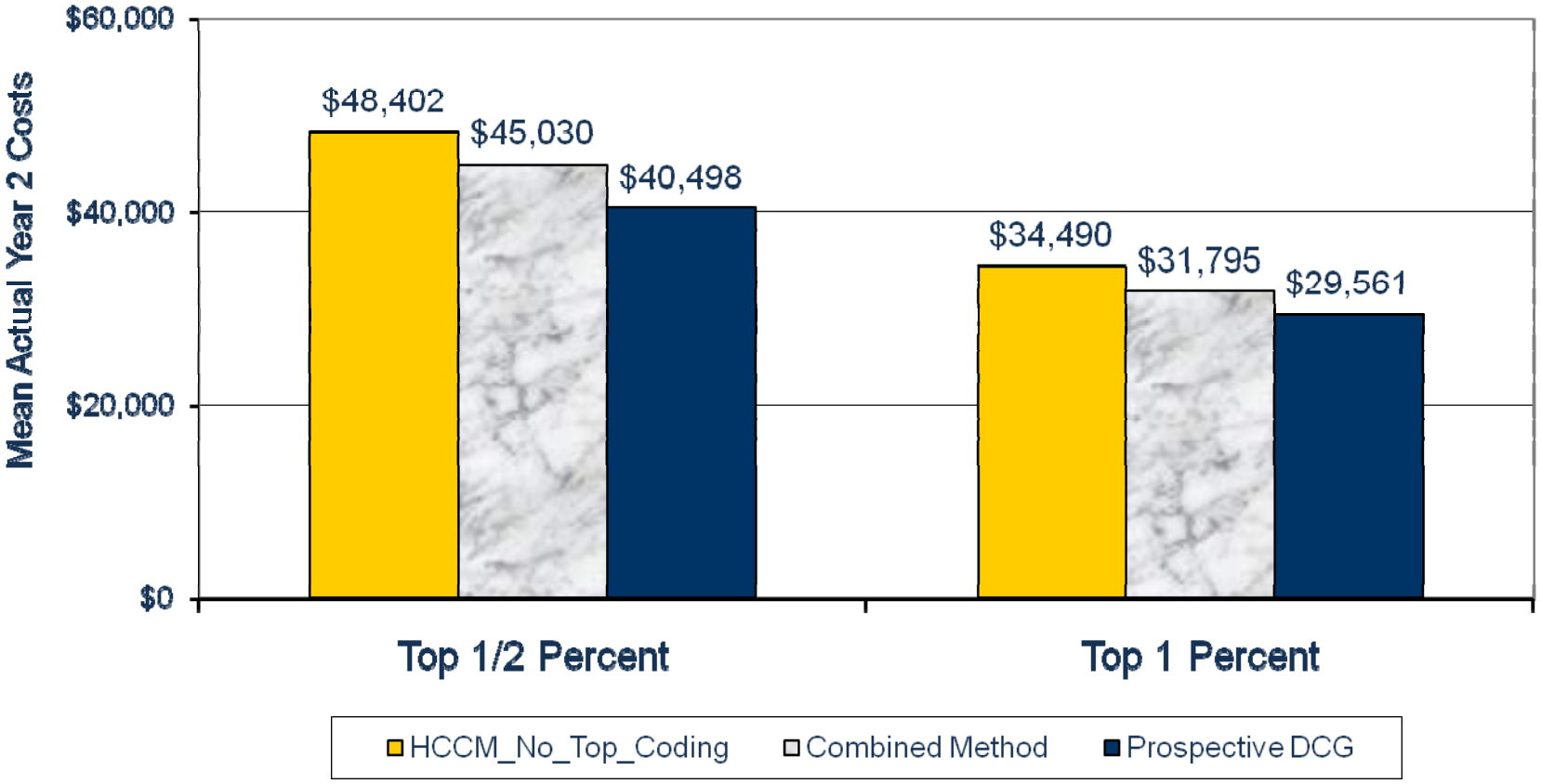
HCCM Identifies Members With Higher Average Actual Year 2 Costs



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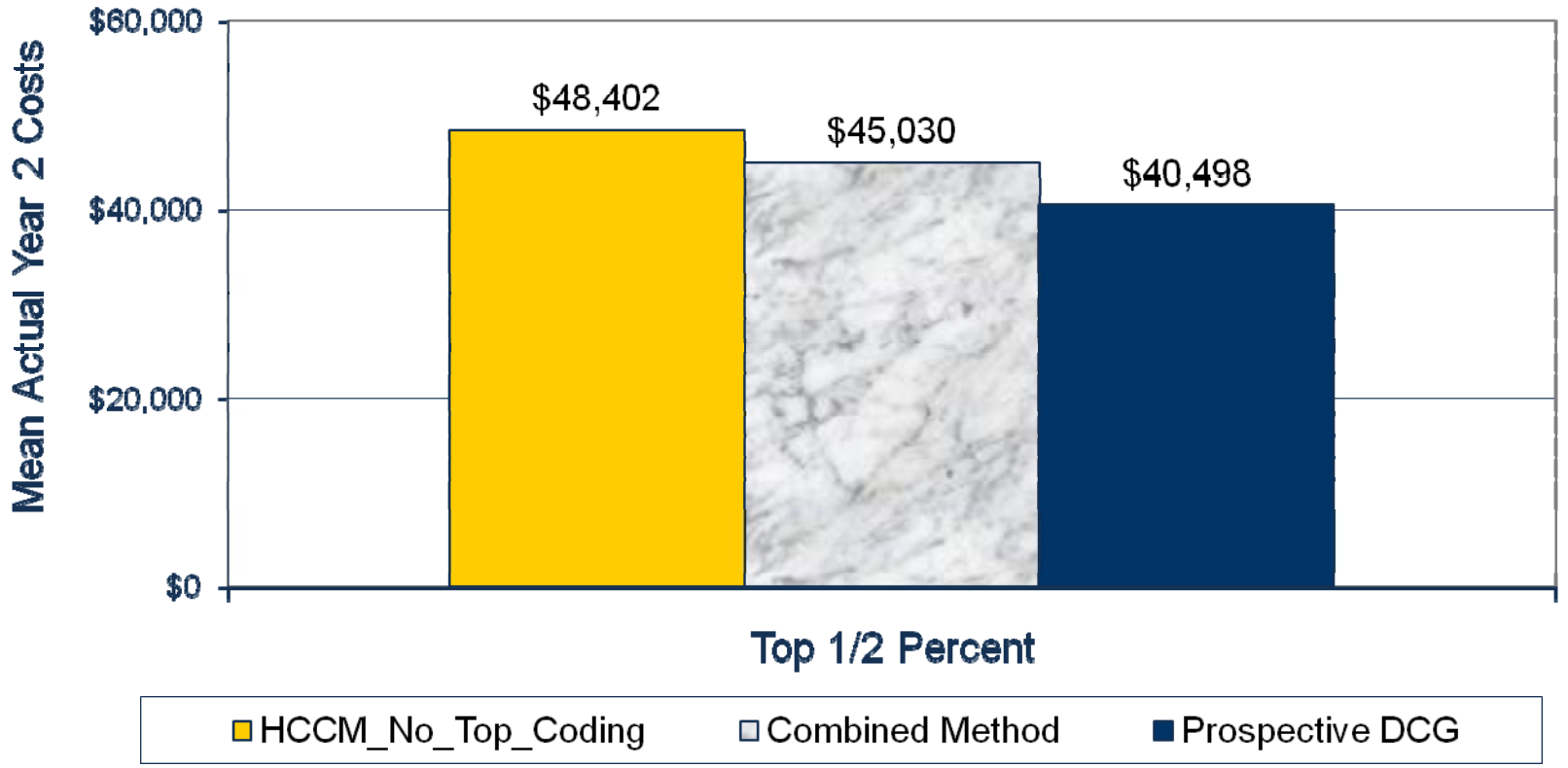
Results for the top ½ percent group (N = 12,727)



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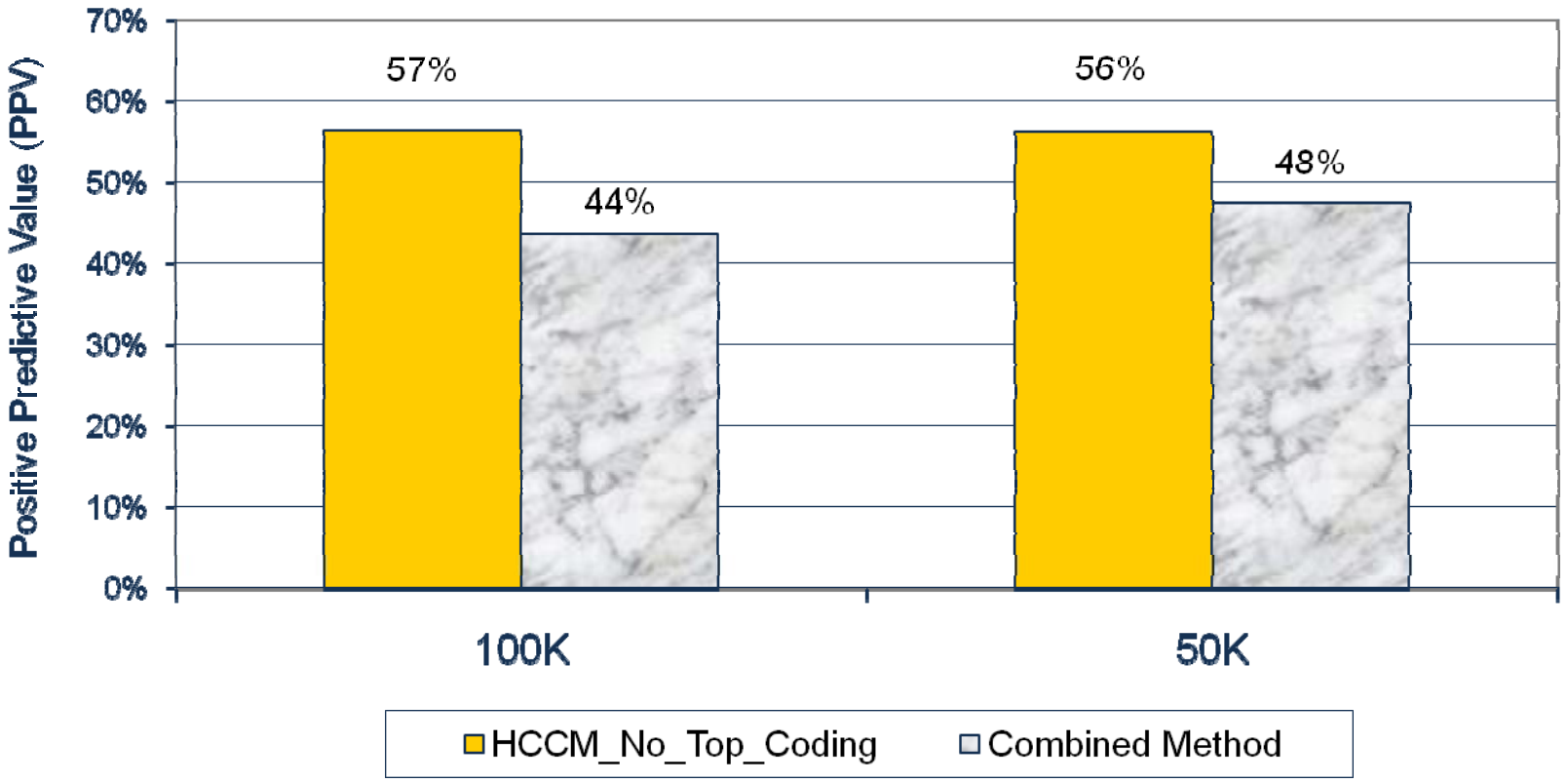
HCCM Has a Higher PPV Compared to the Combined Method (N = 12,727)



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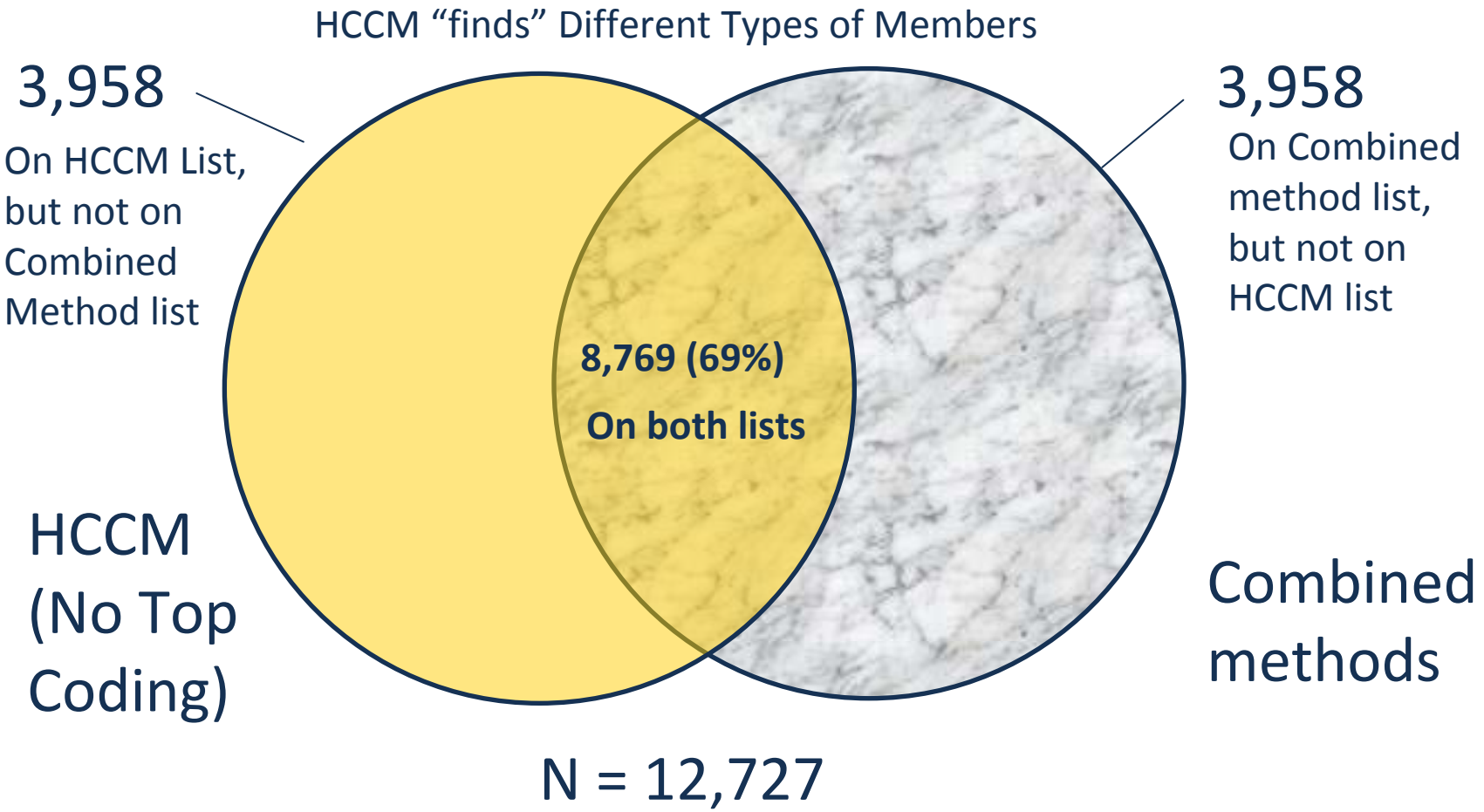
HCCM Model Found 3,958 Individuals Not On the List from the Combined Method



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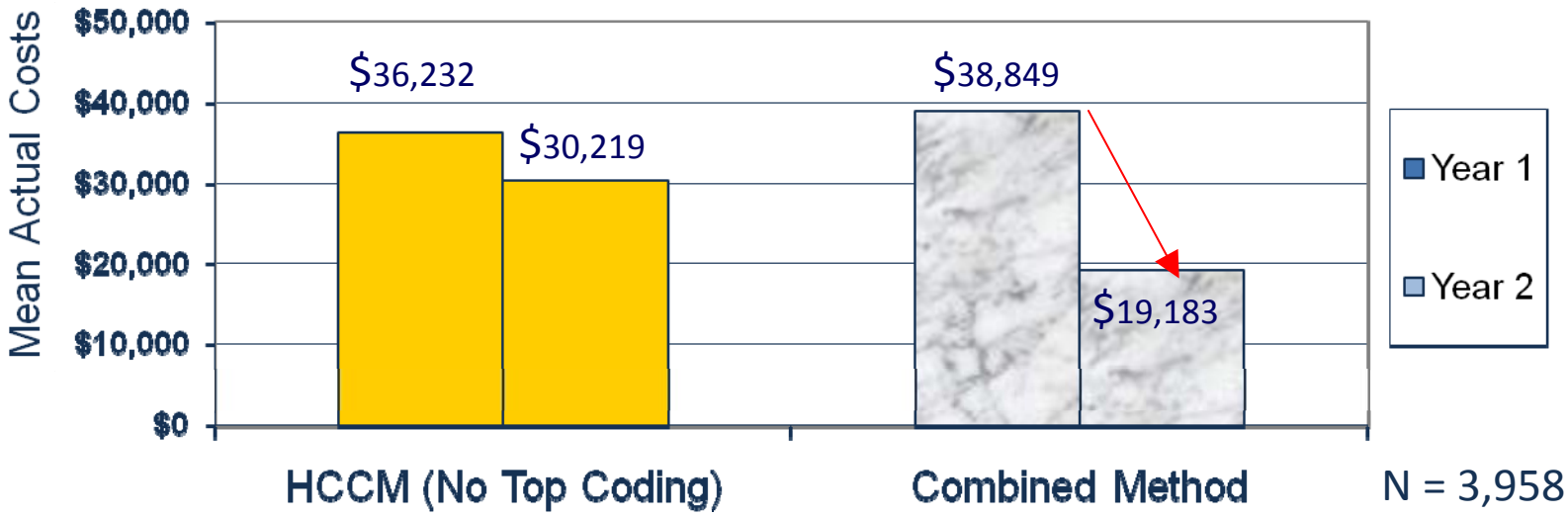
The 3,958 Non Overlapping Members Identified by the Combined Method Illustrate Regression To The Mean



Costs for the Non Overlapping 3,958 Individuals on the Combined List drop by 51% in Year 2. By contrast, the non overlapping 3,958 Individuals on the HCCM List drop by only 17% in Year 2

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The HCCM Model Identifies High Cost Cases Better than Traditional Methods

- 3,958 non overlapping individuals on the HCCM list had total Year 2 costs of more than $120 million
  - Average PMPY is $30,219 as shown on the previous chart
- 3,958 non overlapping individuals on the Combined method list had total Year 2 costs of $76 million
  - Average PMPY is $19,183 as shown on the previous chart

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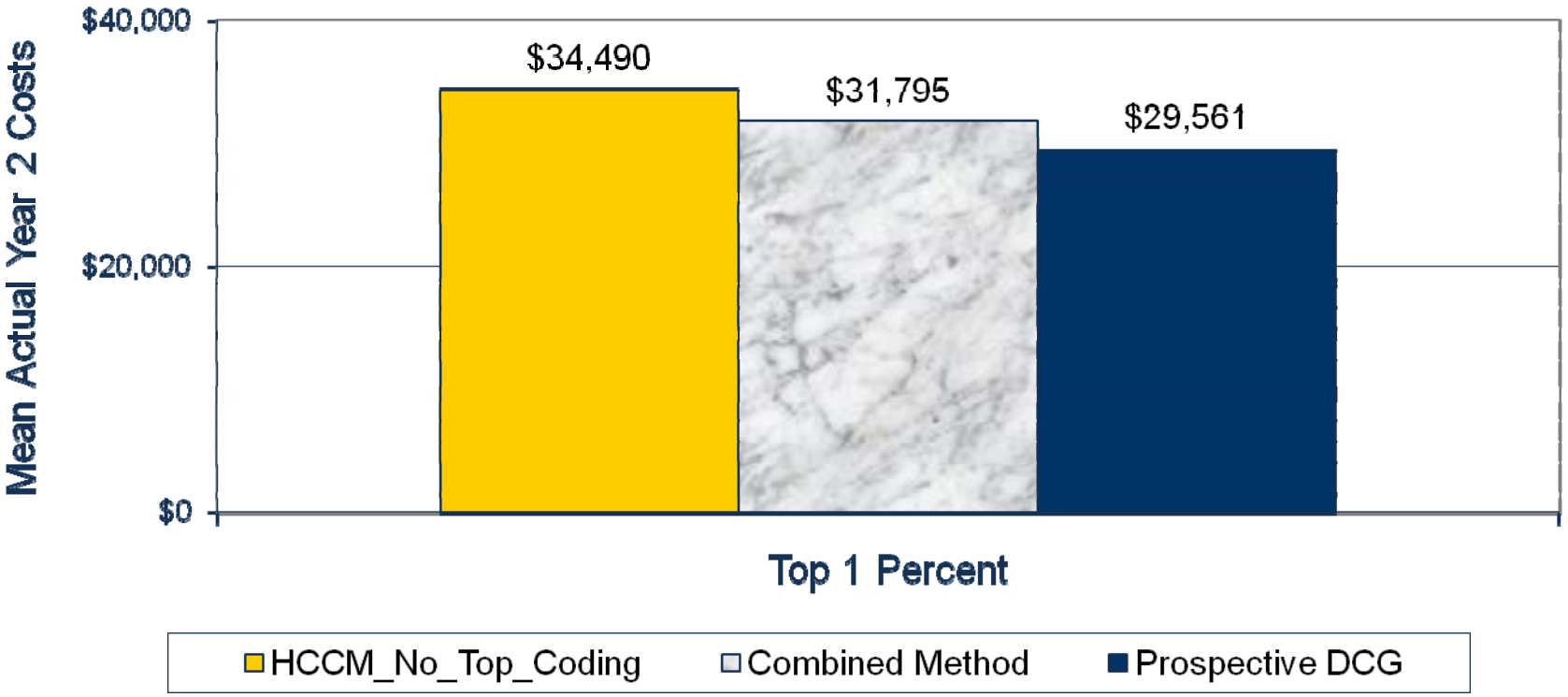
Results for the top 1 percent group (N=25,453)



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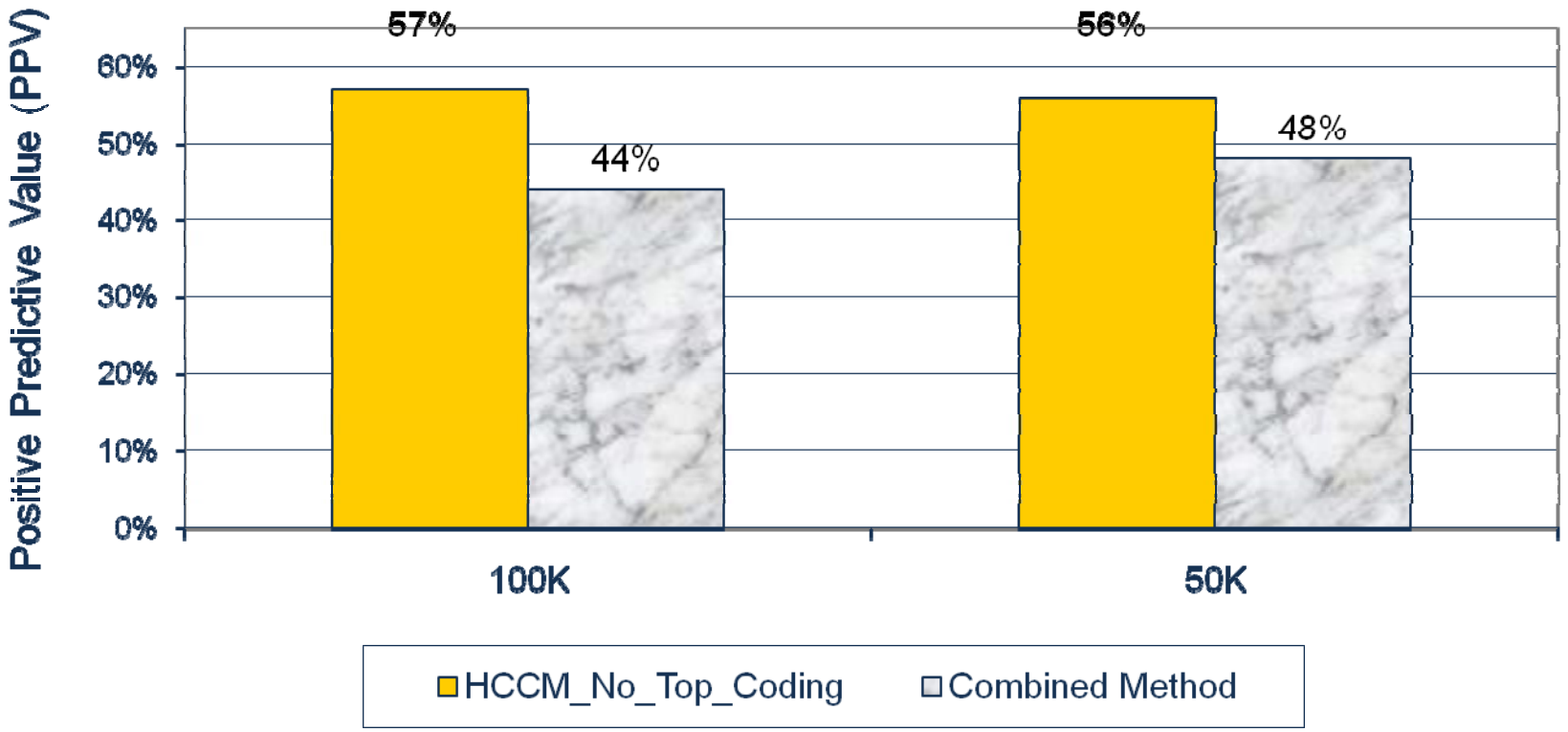
HCCM Has a Higher PPV Compared to the Combined Method (N = 25,453)



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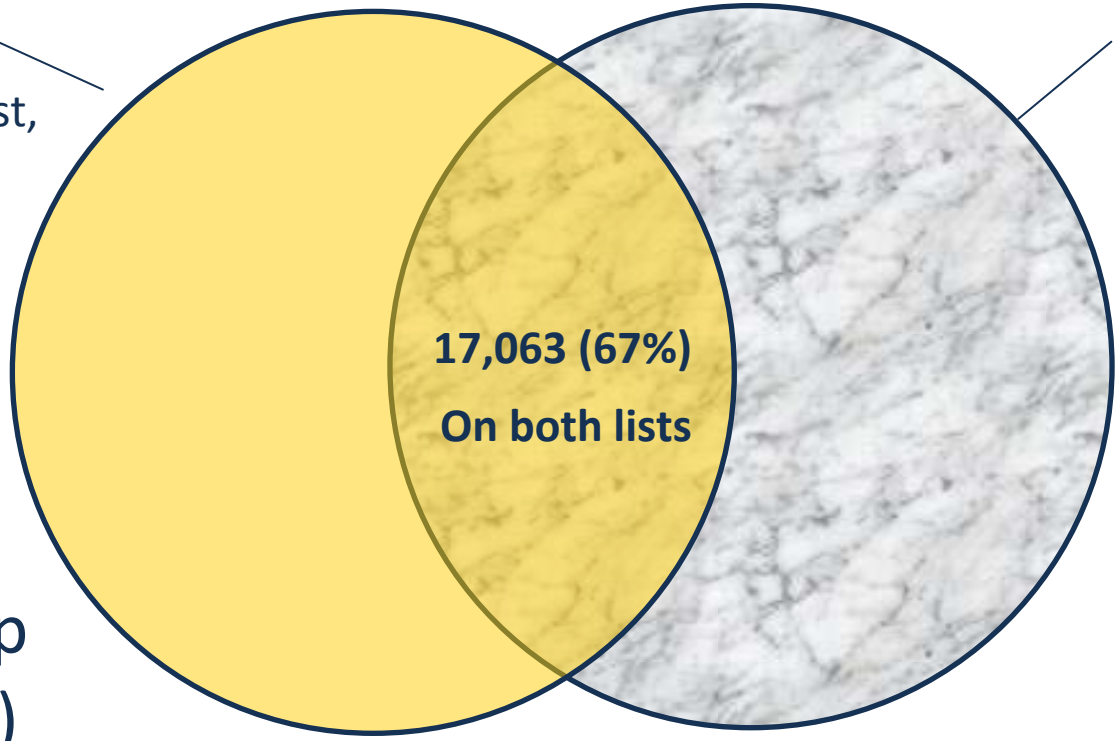
HCCM Model Found 8,390 Individuals Not On the List from the Combined Method

HCCM "finds" Different Types of Members



N = 25,453

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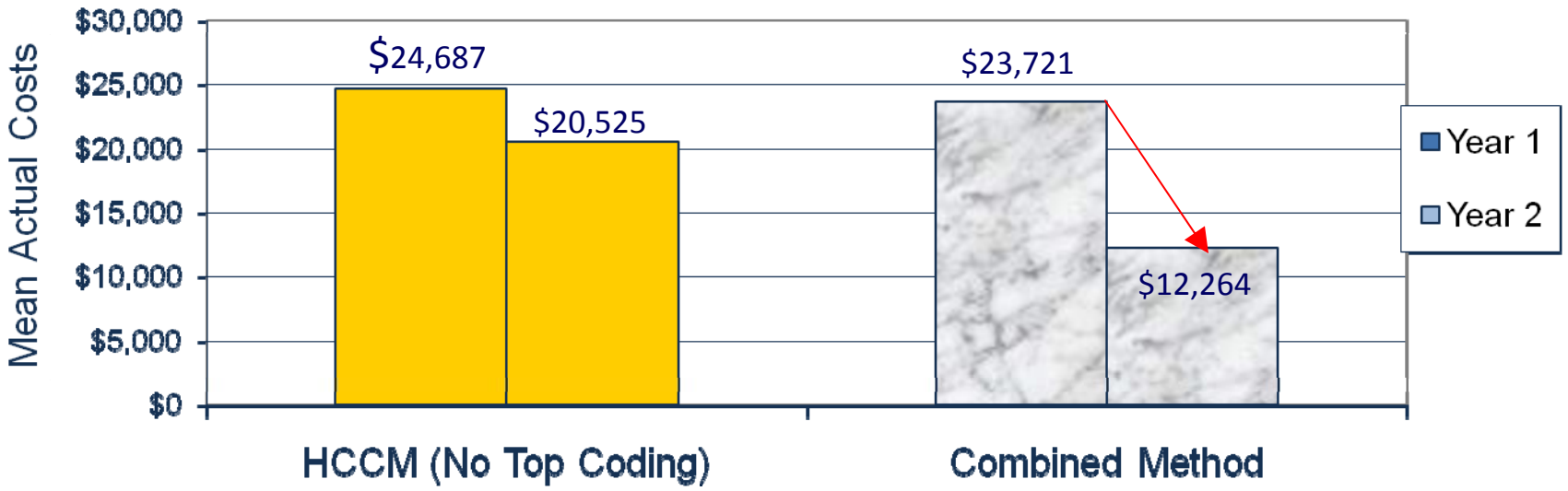
The 8,390 Non Overlapping Members Identified by the Combined Method Illustrate Regression To The Mean



Costs for the Non Overlapping 8,390 Individuals on the Combined List drop by 48% in Year 2. By contrast, the non overlapping 8,390 Individuals on the HCCM List drop by only 17% in Year 2

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The HCCM Model Identifies High Cost Cases Better than Traditional Methods

- 8,390 non overlapping individuals on the HCCM list had total Year 2 costs of more than $172 million
  - Average PMPY is $20,525 as shown on the previous chart
- 8,390 non overlapping individuals on the Combined method list had total Year 2 costs of $103 million
  - Average PMPY is $12,264 as shown on the previous chart

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How are the members in the top groups different?

- Randomly sampled 100,000 lives from Marketscan data set for 2005 and 2006
- Sorted the population using three different methods using 2005 as baseline
  - By High Cost Case Model risk score
  - By Prospective All-Encounter DCG-HCC score
  - By 2005 total allowable claims dollars
- Created 1% top-groups for each method (1,000)

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How are the members in the top groups different?

Top 1% Groups

	% Female	Avg. Age	Hospitalizations 2005	Hospitalizations 2006	Emergency Room 2005	Emergency Room 2006
HCCM	55%	50.1	1.1	0.66	1.3	0.93
Prospective DCG	50%	51.3	1.2	0.67	1.2	0.87
Prior Costs	50%	49.5	1.5	0.61	1.5	0.92

	HCCM Prevalence 2005	HCCM Prevalence 2006		Prosp. DCG Prevalence 2005	Prosp. DCG Prevalence 2006		Prior Cost Prevalence 2005	Prior Cost Prevalence 2006	
Diabetes	277	240	-13%	357	304	-15%	244	200	-18%
CVD	86	49	-43%	101	66	-35%	94	60	-36%
CHF	122	106	-13%	178	140	-21%	118	92	-22%
COPD	113	80	-29%	146	96	-34%	110	57	-48%
VD	132	88	-33%	160	98	-39%	138	72	-48%
CAD	192	156	-19%	231	171	-26%	251	183	-27%
RF	118	91	-23%	176	121	-31%	80	58	-28%
Respiratory	318	224	-30%	345	222	-36%	296	179	-40%

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Aggregated Condition Category Descriptor	HCCM Prevalence	Prosp. DCG Prevalence	Prior Cost Prevalence
ACC001: Infectious and Parasitic	272	270	241
ACC002: Malignant Neoplasm	340	397	297
ACC003: Benign/In Situ/Uncertain Neoplasm	133	116	125
ACC004: Diabetes	277	357	244
ACC005: Nutritional and Metabolic	553	571	564
ACC006: Liver	134	157	115
ACC007: Gastrointestinal	464	463	470
ACC008: Musculoskeletal and Connective Tissue	580	545	590
ACC009: Hematological	354	409	343
ACC010: Cognitive Disorders	54	57	60
ACC011: Substance Abuse	89	100	115
ACC012: Mental	242	205	230
ACC013: Developmental Disability	15	15	24
ACC014: Neurological	248	249	226
ACC015: Cardio-Respiratory Arrest	87	122	117
ACC016: Heart	532	600	601
ACC017: Cerebro-Vascular	86	101	94
ACC018: Vascular	229	262	237
ACC019: Lung	420	452	391
ACC020: Eyes	240	253	230
ACC021: Ears, Nose and Throat	392	365	374
ACC022: Urinary System	365	433	303
ACC023: Genital System	202	194	203
ACC024: Pregnancy Related	12	12	22
ACC025: Skin and Subcutaneous	333	337	316
ACC026: Injury, Poisoning, Complications	433	428	487
ACC027: Symptoms, Signs and Ill-Defined Conditions	802	809	828
ACC028: Neonates	2	9	5
ACC029: Transplants, Openings, Other V-Codes	79	106	77
ACC030: Screening / History	805	799	847

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Aggregated RxGroup Category Descriptor	HCCM Prevalence	Prosp. DCG Prevalence	Prior Cost Prevalence
ARXG001: Analgesics/anti-inflammatories	772	699	798
ARXG002: Anti-hyperlipidemics	373	385	359
ARXG003: Anti-infectives	813	785	784
ARXG004: Coagulants and Anticoagulants	237	238	309
ARXG005: Biologicals	186	169	145
ARXG006: Cardiovascular	619	649	621
ARXG007: Neurological agents	679	588	653
ARXG008: Dermatologicals	372	318	310
ARXG009: EENT preparations	275	236	232
ARXG010: Endocrine/metabolic agents	574	480	488
ARXG011: Diabetes drugs	254	227	202
ARXG012: Pulmonary drugs	247	302	220
ARXG013: GI drugs	665	605	596
ARXG014: Genitourinary agents	241	215	205
ARXG015: Immunologic agents	132	107	61
ARXG016: Nutritionals	301	314	254
ARXG017: Upper respiratory agents	397	339	342
ARXG018: Additional groups	324	346	272

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When to use the High Cost Case Model

- When a plan needs to identify the top ½ percent or top 1% of cases expected to be high cost
  - Care management
- When the business problem is:
  - Identifying cases that are going to be catastrophic (high cost) for the plan
    - Pricing, Underwriting
  - Understanding how many and what kinds of stop loss cases are likely to occur (e.g. in a self-insured account)
  - Understanding if there are excess risk coverage or reinsurance considerations

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Recommended Uses of HCCM Top Coding Choices

- "No top coding" – for budgeting and projecting *total* costs
- $250K and $100K - when predicting costs below these attachment points
- $25k - for use by forecasting actuaries and also disease management professionals
  - Model has the best PPV for predicting those likely to exceed $25k
- HCCM top coding options (250K, 100K and 25K) simulate the impact of reinsurance or stop loss at those levels
  - Top coded models have improved predictive accuracy (as measured by R^2)

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Applications of high cost claim prediction

- More accurate predictions for individuals & groups
- Group by disease, and then rank
  - DM program involvement
- Rank groups or identify groups with higher concentrations of expected high cost claims
  - Rank by expected year 2 cost
  - Monitoring accounts
- Pooling charges in underwriting or self-insured pricing
- Simulation of reinsurance arrangements or risk pools
  - Better estimate the right tail of the claims distribution

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Reinsurance Considerations

- American Re HealthCare (now Munich Re) gave a user conference presentation in 2004 on high cost claim prediction
  - Evaluated several types of models for predicting high cost claims
    - 2-Part Prospective DCG model with simple recalibration
    - 2-Part Prospective DCG model with “total” recalibration
    - Age-sex tables
    - Prior Costs
    - Claims distributions (e.g., Log-normal, discrete continuance tables)

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Reinsurance Considerations (cont'd)

- Risk scores for non-top-coded model reflect total costs
  - You can look at the prevalence of risk scores that would put you over the stop loss threshold (by multiplying by population's average cost)
  - You can look at the prevalence of actual year 2 claims over the stop loss threshold
  - There will be a disconnect!

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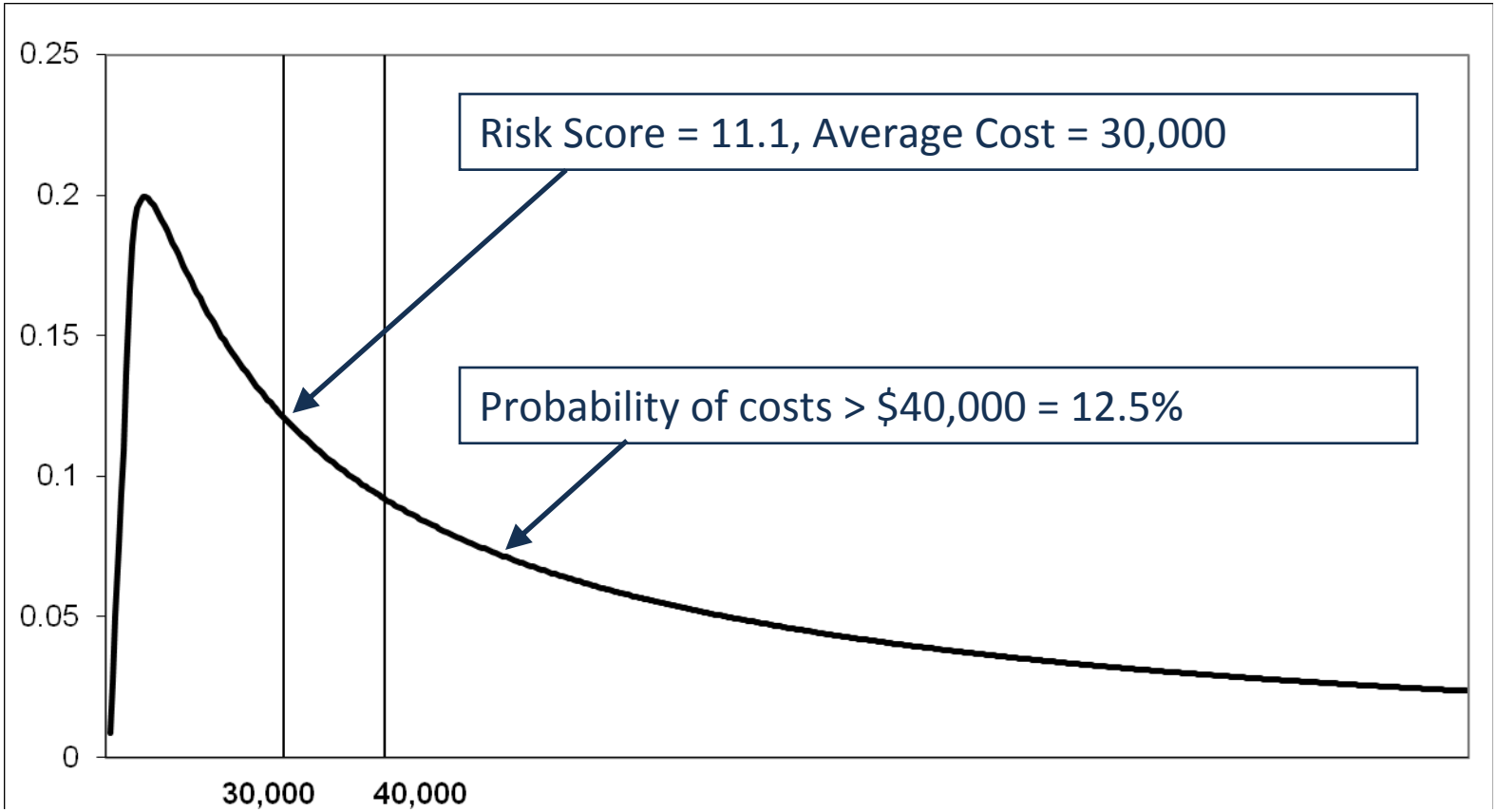
Reinsurance Considerations (cont'd)



From American Re "Using DxCG for Stop Loss and Reinsurance Pricing", 2004 DxCG User Conference Presentation

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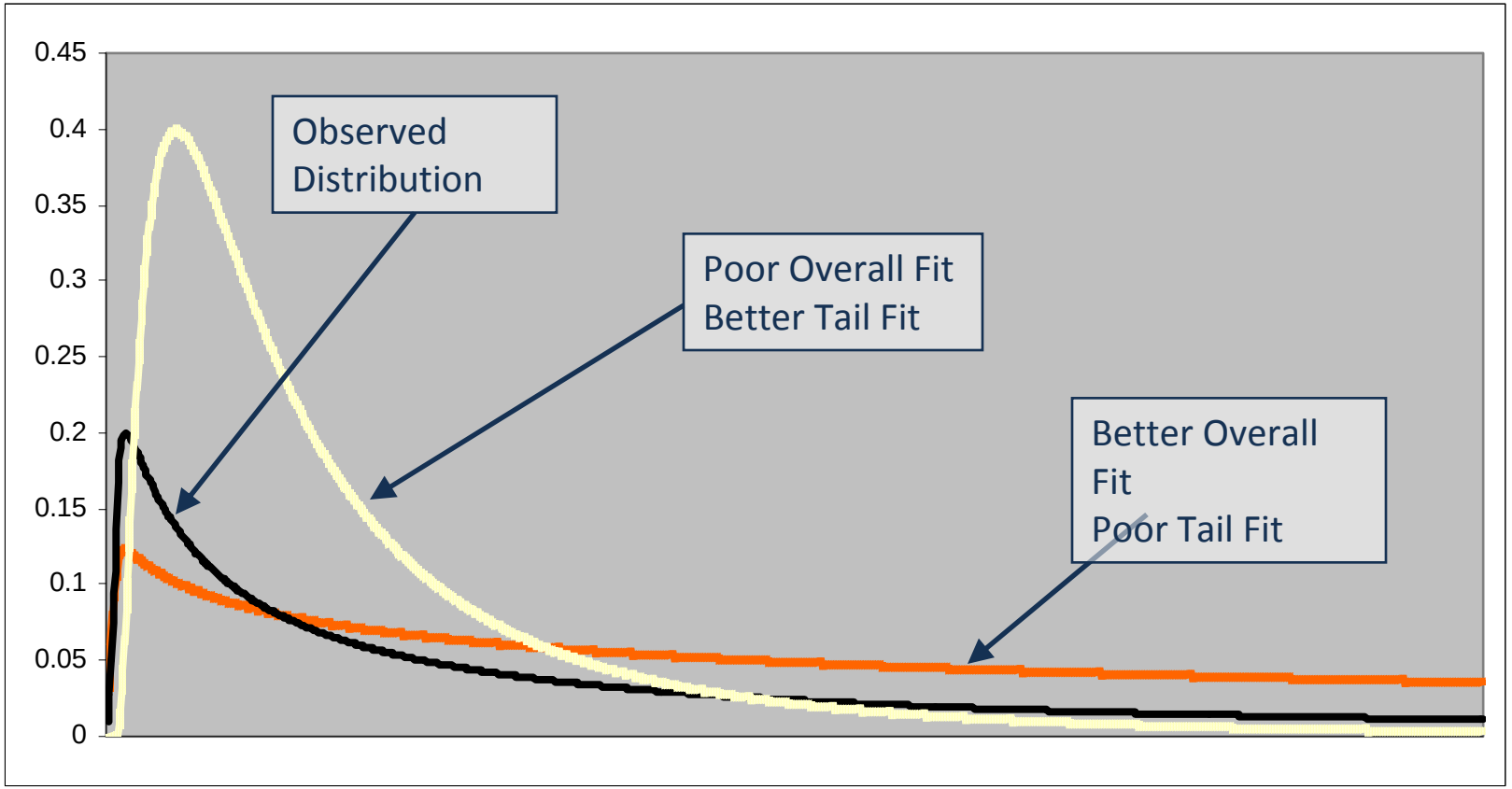
Reinsurance Considerations (cont'd)



From American Re "Using DxCG for Stop Loss and Reinsurance Pricing", 2004 DxCG User Conference Presentation

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American Re retrospective study- methodology

- Methods evaluated:
  - 2-part recalibrations (all HCCs, limited set)
  - Claims distributions based on scores (best fit overall, best fit for top 50%)
  - Age-sex factors
  - Prior year costs
- Looked at ability to identify high cost claimants, excess loss PMPM and grouped R-Squared

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American Re retrospective study- findings

- High cost claim identification
  - Diagnostic models superior in finding high cost claims at all stop loss thresholds
  - Those that the prior cost method successfully identified as high cost had higher excess claims
- PMPM Excess Loss
  - Recalibrated model with limited HCCs was best
  - Prior cost and DxCG raw predictions were equivalent
  - Recalibrated “All HCCs” did not perform well as others

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American Re retrospective study- findings (cont'd)

- Group pricing (PM versus standard methods)
  - Standard methods are age-sex or prior cost
  - Age-sex always worse than diagnostic models
  - Small to mid-size groups (<250): Diagnostic better than prior costs alone (all thresholds)
    - Diagnostic model more limited at $250K threshold

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American Re retrospective study- findings (cont'd)

- Group pricing (within class of PM)
  - At lower thresholds, recalibrated "All HCCs" better
    - Limited HCCs and distributional models equivalent
  - At $100K threshold, recalibrate "All HCCs" model and distributional models equivalent
  - At $250K threshold, the distributional models were better than either of the recalibrated models, though predictive performance was not very strong

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Reinsurance Pooling Scheme

- Large, self-insured employer with national PPO and many Business Units (BUs) each accountable for own healthcare financials
- Corporate decided to “risk-adjust” and bill BUs premiums adjusted to their population
  - Risk premium proxies for Aggregate Stop Loss
  - Billed premiums reconciled with actual claims
  - “Recoveries” paid from Corporate pool, with desired outcome that loss ratios approach 100%

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Pooling Scheme for Self-Insured Employer with Several Business Units

Without Diagnosis-Based Risk Adjustment

Pooled PPO Claim PMPM **$250.00**

Business Unit:	**Corporate**	**XYZ Co.**	**ABC Co.**	**Total**
Membership	45	455	1,500	2,000
Average Age	48	42	36	38
% Male	70%	25%	70%	60%
Demographic Factor Adjustment	**1.15**	**1.05**	**0.98**	**1.00**
(Normalized)				
Business Unit Expected PMPM	$287.50	$262.50	$245.08	$250.00
Risk Pooling Charge as % of Claims	10.0%	7.0%	5.0%	5.6%
Charged Risk Premium PMPM	$28.75	$18.38	$12.25	$14.02
Total Risk Premium Dollars	$15,525	$100,328	$220,575	**$336,428**
Actual Incurred PPO Claims PMPM	$183.75	$367.50	$232.75	$262.30
Initial Business Unit Loss Ratio	63.9%	140.0%	95.0%	104.9%
Actual minus Expected Claims				
PMPM	($103.75)	$105.00	($12.33)	$12.30
Annual Dollars	($56,025)	$573,300	($222,000)	$295,275
Recoveries collected from Pool	$0	**$336,428**	$0	$336,428
Net Owed to the Reinsurance Pool	$0	$236,873	($222,000)	$14,873
Final Business Unit Loss Ratio	63.9%	116.5%	95.0%	

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Without Diagnosis-Based Risk Adjustment

Final Pool Accounting

Starting value	$0
Risk premium collected	$336,428
Recoveries paid to units	($336,428)
Collected from "losers"	$236,873
Paid to "winners"	($222,000)
Ending value	**$14,873**

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With Diagnosis-Based Risk Adjustment				
Pooled PPO Claim PMPM	**$250.00**			
Business Unit:	**Corporate**	**XYZ Co.**	**ABC Co.**	**Total**
Membership	45	455	1,500	2,000
Average Age	48	42	36	38
% Male	70%	25%	70%	60%
Demographic Factor Adjustment *(Normalized)*	1.15	1.05	0.98	1.00
"Hidden Health Information"	*Low incidence of chronic disease for this age group*	*High incidence of diabetes, heart disease and associated comorbidities*	*Young, healthy and invincible*	
Unit's Average Relative Risk Score *(Prospective, Normalized)*	0.85	1.40	0.88	1.00

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With Diagnosis-Based Risk Adjustment				
Pooled PPO Claim PMPM	**$250.00**			
Business Unit:	**Corporate**	**XYZ Co.**	**ABC Co.**	**Total**
Membership	45	455	1,500	2,000
Average Age	48	42	36	38
% Male	70%	25%	70%	60%
Unit's Average Relative Risk Score	0.85	1.40	0.88	1.00
(Prospective, Normalized)				
Business Unit Risk-Adjusted PMPM	$212.50	$350.00	$220.79	$250.00
Risk Pooling Charge as % of Claims	10.0%	7.0%	5.0%	5.7%
Charged Risk Premium PMPM	$21.25	$24.50	$11.04	$14.33
Total Risk Premium Dollars	$11,475	$133,770	$198,713	**$343,958**
Actual Incurred PPO Claims PMPM	$183.75	$367.50	$232.75	$262.30
Initial Business Unit Loss Ratio	86.5%	105.0%	105.4%	104.9%
Actual minus Expected Claims				
PMPM	($28.75)	$17.50	$11.96	$12.30
Annual Dollars	($15,525)	$95,550	$215,250	$295,275
Recoveries collected from Pool	$0	**$95,550**	**$215,250**	$310,800
Net Owed to the Reinsurance Pool	$0	$0	$0	$0
Final Business Unit Loss Ratio	86.5%	100.0%	100.0%	

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With Diagnosis-Based Risk Adjustment

Final Pool Accounting

Starting value	$0
Risk premium collected	$343,958
Recoveries paid to units	($310,800)
Collected from "losers"	$0
Paid to "winners"	$0
Ending value	**$33,157**

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Any Questions?

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