

# Clinical and Performance Characteristics of the Rx-PM Model

**David Bodycombe, Sc.D.<sup>1</sup>**

**Susan dosReis, Ph.D.<sup>2</sup>**

**Kenneth Shermock, Pharm. D.<sup>3</sup>**

**<sup>1</sup>Johns Hopkins Bloomberg School of Public Health**

**<sup>2</sup>Johns Hopkins University School of Medicine**

**<sup>3</sup>Johns Hopkins Hospital**



# What To Expect Today

- Review the conceptual framework for the Rx-PM model
- Present case for validity of Rx-based morbidity groupings
- Provide evidence for strong statistical performance
- Consider potential applications of this model



# A Definition of Predictive Modeling

- The process by which clinical data are used to estimate the risk of future medical service utilization.
- Primary Purposes of PM
  - Case identification
  - Disease management tiering
  - Actuarial forecasting
- PM is a risk adjustment application





“Predictions are hard,  
especially about the  
future.”

Niels Bohr

Nobel Prize Winner in Physics



# Strengths of Alternative Models

Model Type	Strengths
Demographics	Need: weak Demand: no Supply: no
ICD-based (e.g., Dx-PM)	Need: strong for medical services, moderate for medications Demand: intentionally weak Supply: no
NDC-based (e.g., Rx-PM)	Need: strong for medications, moderate for medical Demand: moderate for medications Supply: no
Prior Costs	Need: moderate Demand: moderate Supply: moderate



# Rx-PM Conceptual Framework

- Grounded in the Principles of Pharmacotherapy Prescribing
  - Underlying morbidity
    - Approved diagnostic indication
  - Pharmacological properties
    - Mechanism of action
    - Delivery of the medication to site of action

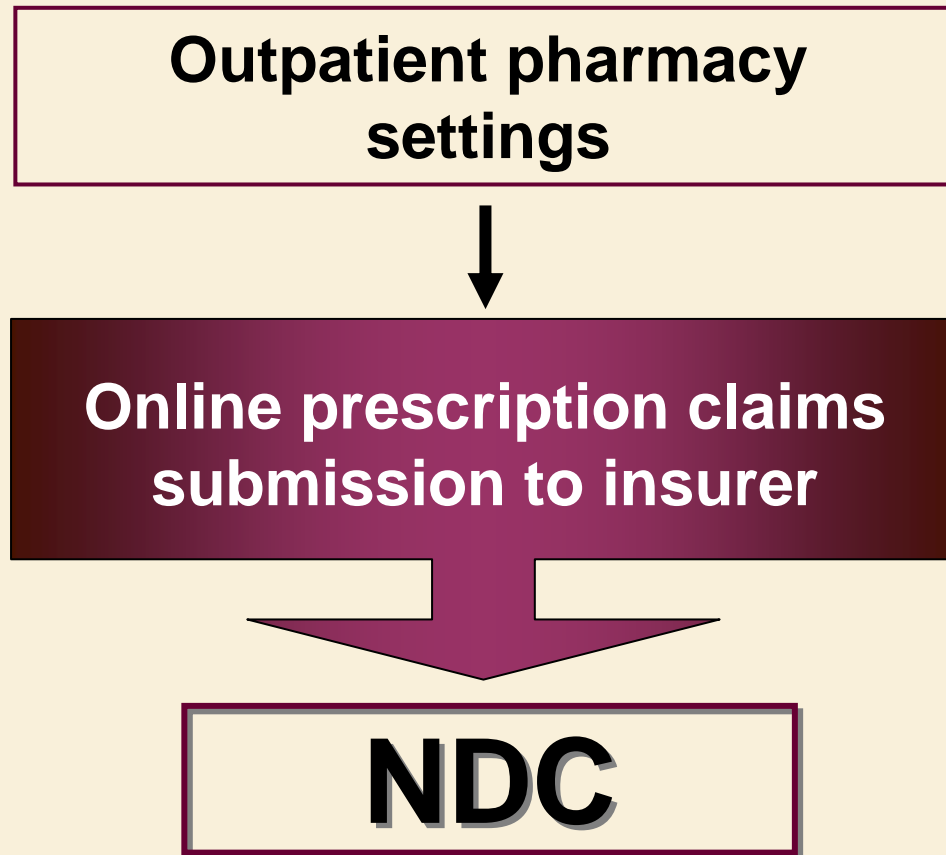


# Clinical Criteria for Classification

- Underlying morbidity
  - Most common morbidity-type
    - symptom, disease/diagnosis
  - Duration of morbidity
    - chronic, time-limited
  - Stability of morbidity
    - stable, unstable
- Pharmacological properties
  - Therapeutic goal
    - curative, palliative, preventive
  - Route of administration
    - oral, topical, intramuscular, intravenous



# National Drug Codes (NDC) Are Primary Data Inputs



# Difficulties in Working with Rx Data

- **Drug use is NOT synonymous with presence of specific diseases**
  - Multiple indications for same drug
    - Approved uses
    - Off-label uses
  - There are no definitive drug therapies for some conditions
- **Patterns of practice can directly influence risk scores**
- **Complexities of working with drug codes**
  - Actual product dispensed may be different from drug of record

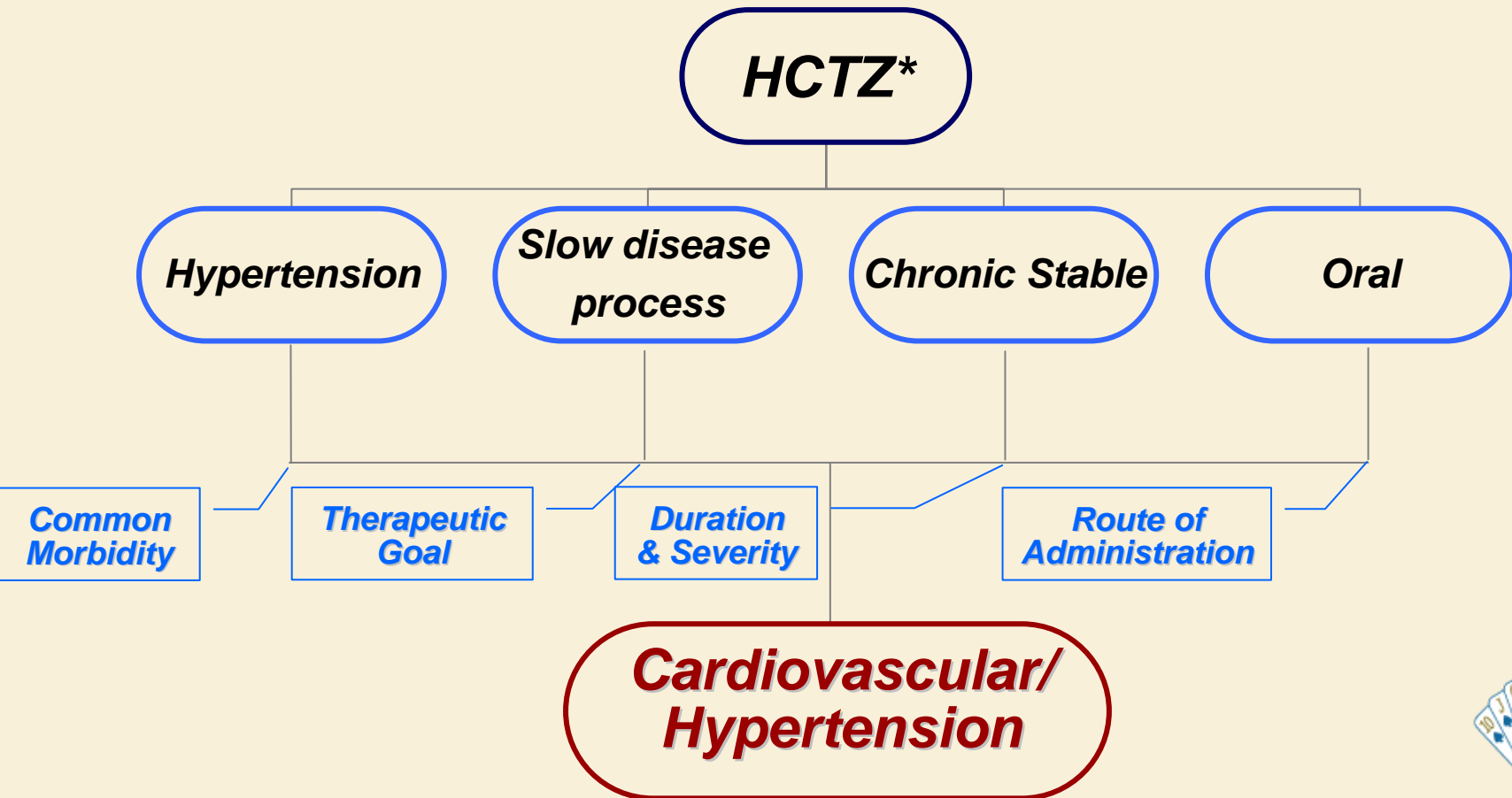


# The Major Rx-MG Categories

- Allergy/Immunology
- Cardiovascular
- Ears, Nose, Throat
- Endocrine
- Eye
- Female Reproductive
- Gastrointestinal/Hepatic
- General Signs & Symptoms
- Genito-urinary
- Hematologic
- Infections
- Malignancies
- Musculoskeletal
- Neurologic
- Psychosocial
- Respiratory
- Skin
- Toxic Effects/ Adverse Reactions
- Others / non-specific medications



# Example of Medication Classification



# The GI/Hepatic Rx-MG Categories

<b>Gastrointestinal / Hepatic</b>	
<b>Rx-MG</b>	<b>Exemplary Therapeutic Classes</b>
Acute minor-palliative	Antidiarrheals, laxatives, antacids
Chronic liver disease	Interferons, penicillamine
Chronic stable	Gallstone solubilizing agents
Inflammatory bowel disease	5-aminosalicylates, infliximab
Pancreatic disorders	Digestive enzymes
Peptic disease	Proton pump inhibitors, H2 antagonists, GI stimulants



Patient Clinical Profile Over One Year

<b>Patient #1</b> <b>3 Rx-MGs</b>	<b>Patient #2</b> <b>4 Rx-MGs</b>	<b>Patient #3</b> <b>11 Rx-MGs</b>
<b>Genito-Urinary / Acute Minor: Palliative</b>	<b>Cardiovascular / High Blood Pressure</b>	<b>Allergy/Immunology / Acute Minor: Palliative Allergy/Immunology / Asthma</b>
<b>Respiratory / Acute Minor: Palliative</b>	<b>Cardiovascular / Hyperlipidemia</b>	<b>Endocrine / Chronic Medical</b>
<b>Skin / Acute and Recurrent</b>	<b>Genito Urinary / Acute Minor: Palliative</b>	<b>Gastrointestinal/Hepatic / Acute Minor: Palliative</b>
	<b>Infections / Acute Minor: Curative</b>	<b>General Signs and Symptoms / Nausea and Vomiting General Signs and Symptoms / Pain</b>
		<b>Infections / Acute Minor: Curative</b>
		<b>Psychosocial / Anxiety Psychosocial / Depression</b>
		<b>Respiratory / Acute Minor: Palliative Respiratory / Chronic Medical</b>



# Patient Clinical Profile Over One Year

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Rx-ACG – Predicted Cost	<b>\$2,754</b>	<b>\$4,151</b>	<b>\$7,900</b>
Percentile Rank	<b>80%</b>	<b>90%</b>	<b>98%</b>
Age	<b>59</b>	<b>57</b>	<b>39</b>
Sex	<b>M</b>	<b>M</b>	<b>F</b>

*Data Source: PharMetrics, a unit of IMS, Watertown, MA*



# Source of Data on Commercially-Insured Individuals

- Computerized medical and pharmacy claims
  - PharMetrics (*PharMetrics, a unit of IMS, Watertown, MA*)  
Patient-Centric database
  - 2.4 billion medical and/or pharmacy encounters
  - Over 47 million individuals across all levels of care
  - 85 geographically diverse health plans
  - Representative of families of middle/upper class, employed population
- Demographic and clinical data
  - Age and gender
  - International Classification of Disease 9<sup>th</sup> Edition (ICD-9)
  - National Drug Codes (NDC)



# Sample Selection

- Population of 6,134,329 in 2002
- Study sample
  - 2,259,584 (37%) of the initial sample
  - Individuals less than 65 years old
  - Enrolled a minimum of 6 months in 2001 and 6 months in 2002
- Exclusions
 

– No prescription benefits	613,098 (10%)
– <6 months of benefits	1,461,471 (24%)
– Unknown coverage type	3,533 (0.05%)
– Indemnity coverage	2,043 (0.03%)
– 65 years or older	98,386 (1.6%)



# Development and Validation Samples

- Development sample  
(n=1,355,577)
  - Create the predictive models
  - Assign weights to risk factors
- Validation sample (n=904,007)
  - Analysis of 587,463 with pharmacy benefits



# Assessing Model Performance

- Predictive models
  - Prior cost not a predictor
- ACG Rx-PM compared with ACG Dx-PM
  - Sensitivity
  - Positive predictive value
  - C-statistic
  - Proportion correctly identified with significant morbidity/associated costs
- Outcome measure
  - High risk - top 5% of costs in year 2



# Females in the Study Population Tend to be Somewhat Older

	Female		Male	
	n	%	n	%
<b>Overall</b>	<b>325,902</b>	<b>100.0</b>	<b>261,525</b>	<b>100.0</b>
<b>Age category</b>				
<b>&lt;5</b>	19,528	6.0	20,905	8.0
<b>5-9</b>	20,466	6.3	22,105	8.5
<b>10-14</b>	20,156	6.2	21,632	8.3
<b>15-19</b>	22,081	6.8	20,283	7.8
<b>20-35</b>	76,506	23.5	47,524	18.2
<b>36-50</b>	103,299	31.7	78,074	29.9
<b>51-64</b>	63,866	19.6	51,002	19.5



\*36 individuals could not be classified by age and gender

## The Rx Morbidity Profile Suggests A Relatively Healthy Population

Common Morbidity Group*	Unique Occurrences Among Patients	
	N	%
Infections	371,971	20.35
General Signs and Symptoms	272,912	14.93
Respiratory	178,682	9.77
Allergy/Immunology	156,814	8.58
Cardiovascular	153,815	8.41
Psychosocial	153,314	8.39
Skin	137,003	7.49
Endocrine	105,209	5.75
Female Reproductive	81,363	4.45
Gastrointestinal/Hepatic	77,202	4.22
Eye	56,660	3.10



# Profiles of Persons With Specific Diseases That Are Identified by Pharmacy Data Make Sense



<b>Diabetes</b>		<b>N</b>	<b>%</b>
		N=19,748	
<b>Gender</b>	Male	10463	53.0
	Female	9285	47.0
<b>Age</b>	<20 years old	677	3.4
	20-64 years old	19,068	96.6
<b>Common Morbidity Groups</b>	Endocrine	26,953	23.8
	Cardiovascular	24,063	21.3
	General Signs/Symptoms	12,887	11.4
	Infections	11,488	10.2
	Psychosocial	7,154	6.3
	Respiratory	6,170	5.5



<b>Asthma</b>		<b>N</b>	<b>%</b>
		N=61,681	
<b>Gender</b>	Male	28,026	45.4
	Female	33,655	54.6
<b>Age</b>	<20 years old	25,511	33.5
	20-64 years old	36,168	58.6
<b>Common Morbidity Groups</b>			
Respiratory		85,407	28.6
Infections		46,117	15.4
Allergy/Immunology		38,568	12.9
General Signs/Symptoms		28,601	9.6
Psychosocial		18,475	6.2
Cardiovascular		15,837	5.3



## Hypertension

N

%

N=79,688

### Gender

Male

38,269

48.0

Female

41,419

52.0

### Age

<20 years old

1,470

1.8

20-64 years old

78,209

98.2

### Common Morbidity Groups

Cardiovascular

121,658

28.8

General Signs/Symptoms

53,021

12.6

Infections

44,734

10.6

Endocrine

37,734

8.9

Psychosocial

34,919

8.3

Allergy/Immunology

25,421

6.0



## Depression

N

%

N=82,497

### Gender

Male

26,454

32.1

Female

56,043

67.9

### Age

<20 years old

7,055

8.6

20-64 years old

75,441

91.4

### Common Morbidity Groups

Psychosocial

115,135

25.9

General Signs/Symptoms

62,549

14.1

Infections

51,563

11.6

Cardiovascular

36,217

8.1

Respiratory

30,313

6.8

Allergy/Immunology

28,797

6.5



# Model Performance

		Diagnosis-based Model	Rx-Defined Model	
<b>Diabetes</b>	<b>Positive Predictive Value</b>	35.01	29.99	
	<b>C-statistic</b>	0.81	0.78	
	<b>Proportion Identified</b>	Prior Costs + ACG PM	25.71	20.57
		Unique ACG PM	9.30	9.42
<b>Hypertension</b>	<b>Positive Predictive Value</b>	32.33	28.04	
	<b>C-statistic</b>	0.80	0.76	
	<b>Proportion Identified</b>	Prior Costs + ACG PM	22.42	18.15
		Unique ACG PM	9.91	9.89
<b>Asthma</b>	<b>Positive Predictive Value</b>	35.78	37.35	
	<b>C-statistic</b>	0.85	0.85	
	<b>Proportion Identified</b>	Prior Costs + ACG PM	26.30	26.23
		Unique ACG PM	9.39	11.12
<b>Depression</b>	<b>Positive Predictive Value</b>	32.43	31.18	
	<b>C-statistic</b>	0.81	0.79	
	<b>Proportion Identified</b>	Prior Costs + ACG PM	22.59	21.44
		Unique ACG PM	9.83	9.75

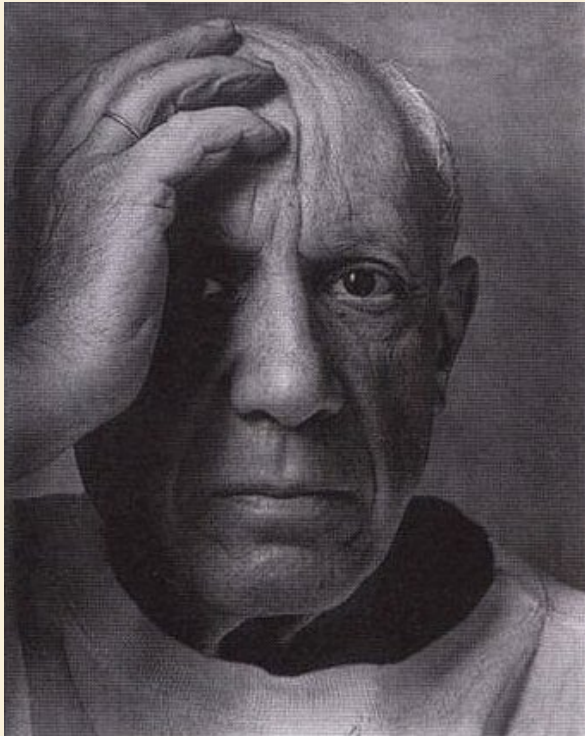


# Rx-Based Models Can Replace Dx- Based Approaches

- Pharmacy-Based Predictive Models Show Performance Similar to Dx-Based Approaches
- Pharmacy Models May Prove to be Superior to Dx-Based Approaches When Drug Therapies Are Prominent
- While A Dx-Based Approach Appears Slightly Superior for Case Identification, The Rx-Based Approach Is Equivalent In Capturing Cases Missed Using Prior Cost
- Rx-Based Models Appear to Be a Viable Alternative to Dx-Based Approaches



# Questions??



“Computers are useless. They can only give you answers.”

Pablo Picasso



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