# Clinical applications of a medical rules-based predictive modeling system

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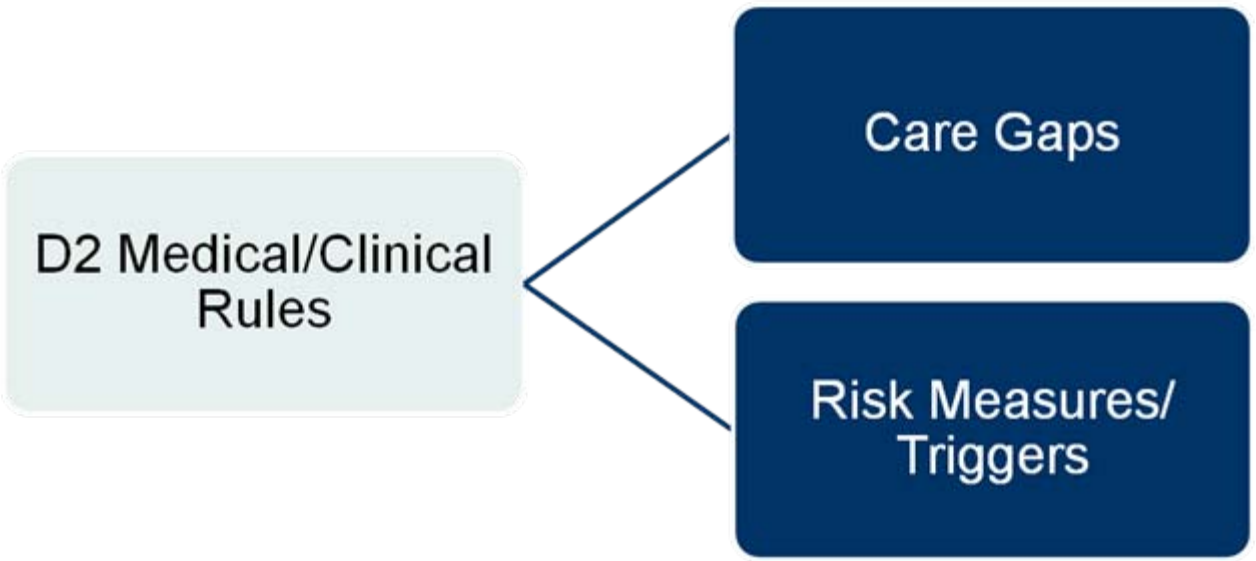
# Presentation Outline

- Objectives
- Terminology and Structure of Medical Rules
- Risk/Predictive Model Development
- Analysis of “Impactable” Cost using the Risk Modeling System
- Conclusions/Q and A

# Overview of D2 Medical/Clinical Rules



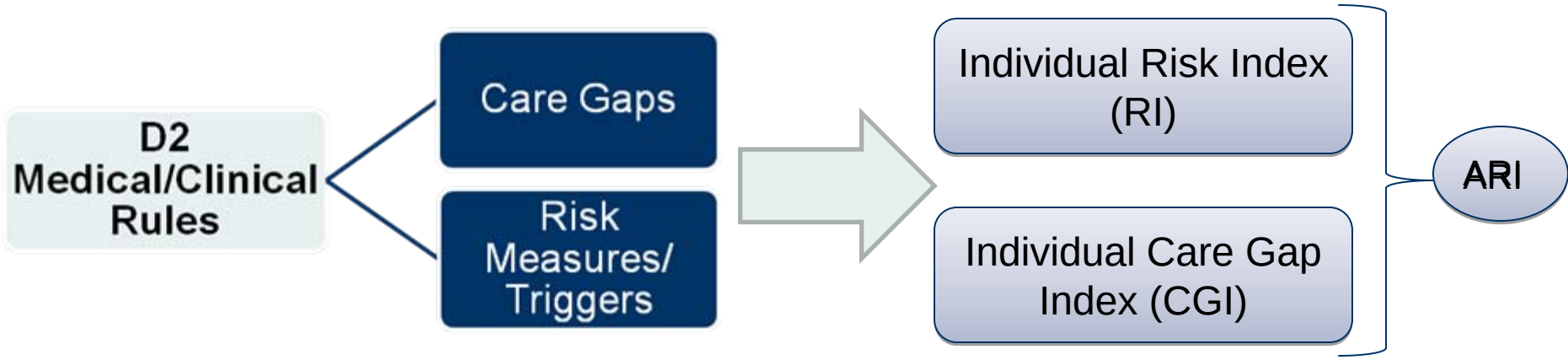

The D2 diagnostic and procedural groupers underpin many of the rules that power our risk models

# D2Hawkeye Medical/Clinical Rules

## Overview of Care Gaps and Risk Measures

- Medical rules are generated in the broad categories of Care Gaps and Risk Measures.
  - *Care Gaps* are specifically focused on evaluating, both at an individual and population/cohort level, the quality and appropriateness of care being delivered.
  - *Risk Measures* are focused on identifying patients with the highest disease burden from their diagnoses, procedures, and drugs, both independently and in combination. These measures are also performed at both the individual and population/cohort level.

# D2 Individual Level Assessment



# Summary of Risk Modeling System

| | Risk Index | Care Gap Index |
|---|---|---|
| **Tag-line** | The disease burden | The intervention opportunity |
| **What is it?** | A numeric score derived for each individual calculated by summing the "weight" allocated to each diagnosis, procedure (especially acute care utilization) and drug, or combination of these elements. | A numeric score assigned to each individual calculated by summing the weights assigned to each care gap present. Care gaps are derived from evidence-based guidelines, the primary medical literature, standard medical practice, and the D2 Medical Advisory Board. |
| **Questions it Answers** | • Who are our sickest members?<br>• How can we quantify the disease burden?<br>• What is the predicted cost for a given individual or group over the next 12 months? | • Who is missing important care opportunities?<br>• Which individuals should be targeted for intervention?<br>• What is the modifiable cost? |
| **Predicts/ Describes** | Heavy disease burden, likelihood of high resource utilization and high future cost over the next 12 months. | Increased future health issues (and potentially acute service utilization) that can be attributed to care gaps or quality of care issues. |

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# Risk Measure/Predictive Model Development

## *Risk Measure Sources*

**1**

- NCQA/HEDIS
- Specialty associations (e.g. ADA, ACS)
- Government (e.g. CMS, USPTF)

- Evidence-based medical practice
- Standard medical practice
- Medical literature review

- Specialist/expert input from Harvard/MIT medical community
- D2 Medical Advisory Board

- Same as care gap sources
- Clinically based rules from these sources are used for population stratification and selectively for predictive models

**2**

- Review of specific groups of high cost cases:
  - Using 3 years of data, D2 Research team performs a detailed review of events occurring prior to high cost final 12 months
  - From this information, new rules are generated and tested for predictive capability

- Collaboration with MIT operations research department allows use of advanced statistical techniques to generate additional ideas for new risk measures
- In particular, clustering is used to generate new ideas for risk measures

- Separate, but related development effort to that is used for care gaps
- Statistically based rules from these sources are always used for predictive models and selectively used for population stratification

# Examples of Risk Measures/Triggers

| QRM | | | # of Members | | | % of Members Meeting Criteria | |
|---|---|---|---|---|---|---|---|
| Group | Condition | Description | With Condition | Meeting Criteria | Not Meeting Criteria | Actual | Norm |
| | | | | | | | |
| Geriatric | General | Members >=65 y/o With Discharge From Inpatient Facility with Readmission within 7 Days in the Analysis Period | 511 | 54 | 457 | 10.57% | |
| Geriatric | Osteoporosis | Members >= 65 y/o with a Fracture of Hip, Spine or Radius in the Analysis Period | 2,205 | 33 | 2,172 | 1.5% | |
| Mental Health | Mental Health | Members with Diagnosis of Depression Taking SSRIs and Bupropion in the Analysis Period | 1,942 | 226 | 1,716 | 11.64% | |
| Mental Health | Mental Health | Members with depression or taking more than 2 prescriptions of antidepressants with any two of these: new pain code (joints, back, neck, abdominal, headache); Opiates; Insomnia/taking sleep medications. | 1,942 | 668 | 1,274 | 34.4% | |
| Pharmacy | Osteoarthritis | Osteoarthritis with continuous use of opiates for more than 12 months | 1,272 | 192 | 1,080 | 15.09% | 15.96% |
| Risk Measures | > 1 ER visit | > 1 ER visit without office visit in last 12 months | 2,592 | 335 | 2,257 | 12.92% | 9.11% |
| Risk Measures | CAD | CAD with MI related hospitalization | 1,249 | 135 | 1,114 | 10.81% | 7.45% |

# Statistical Methods Overview

- **Rule Building:** *Clustering* is used alongside intensive case review/auditing, primary medical literature and expert input to generate new rules for assessing risk in the population.

- **Rule Testing:** *Logistic and linear regression* are used to test the predictive capability of the proposed new rules. Those with the highest performance level are included in the models. Some other rules may be used for population stratification, but not used in our predictive models.

- **Model Building:** Statistically developed, verified and tested rules are then integrated together using D2's proprietary engine to assign final RI scores.

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# Analysis of Risk Modeling System: Data Preparation

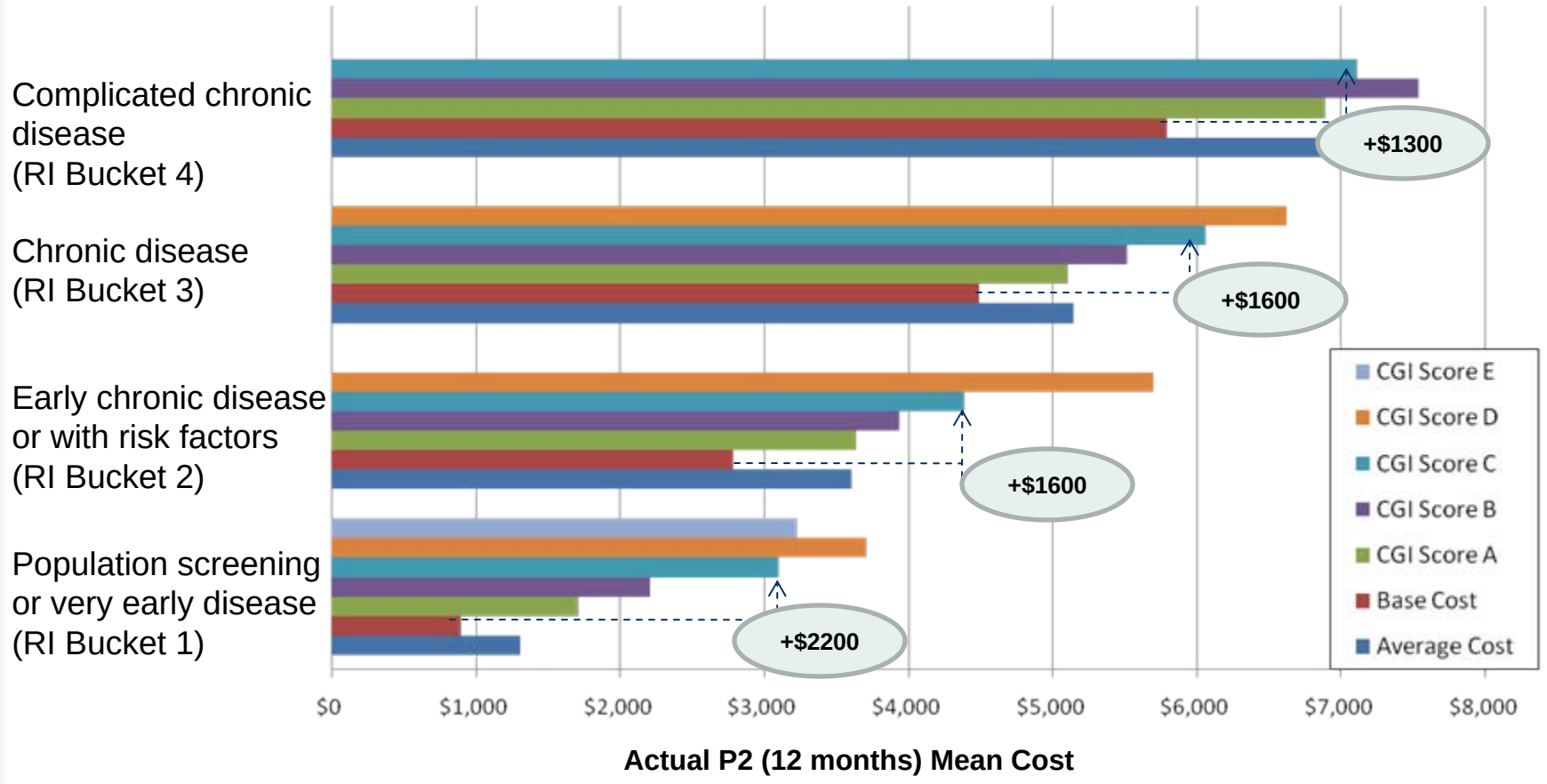
- **Took random sample of our normative database (220,000 from overall size of 9.5M at time of analysis)**
- **Using 3 years of data, created two time periods:**
  - Period 1: First 24 months (P1)
  - Period 2: Last 12 months (P2)
- **Inclusion criteria included eligibility at the end of P1**

# Analysis of Risk Modeling System: RI grouping

In order to examine the “impactable” cost (as measured by the Care Gap Index), we group individuals by their degree of risk (as measured by the Risk Index) as shown below:

| RI “Bucket” | RI Range | % of Individuals | Average Age | Characteristics of individuals and types of care gaps in each range |
|---|---|---|---|---|
| 1 | 1-5 | 82% | 30.7 | Need screening tests only |
| 2 | 6-10 | 7% | 45.6 | Need screening tests, some risk factor modification, and may have some chronic disease |
| 3 | 11-14 | 5% | 46.5 | Have chronic disease and need some recommended diagnostic testing and/or therapy |
| 4 | 15-17 | 2% | 50.6 | Have chronic disease, often with complications, and need more recommended diagnostic testing and/or therapy |
| 5 | 18+ | 4% | 54.9 | Have chronic disease with complications, may also have some acute issues, and need more recommended diagnostic testing and/or therapy |

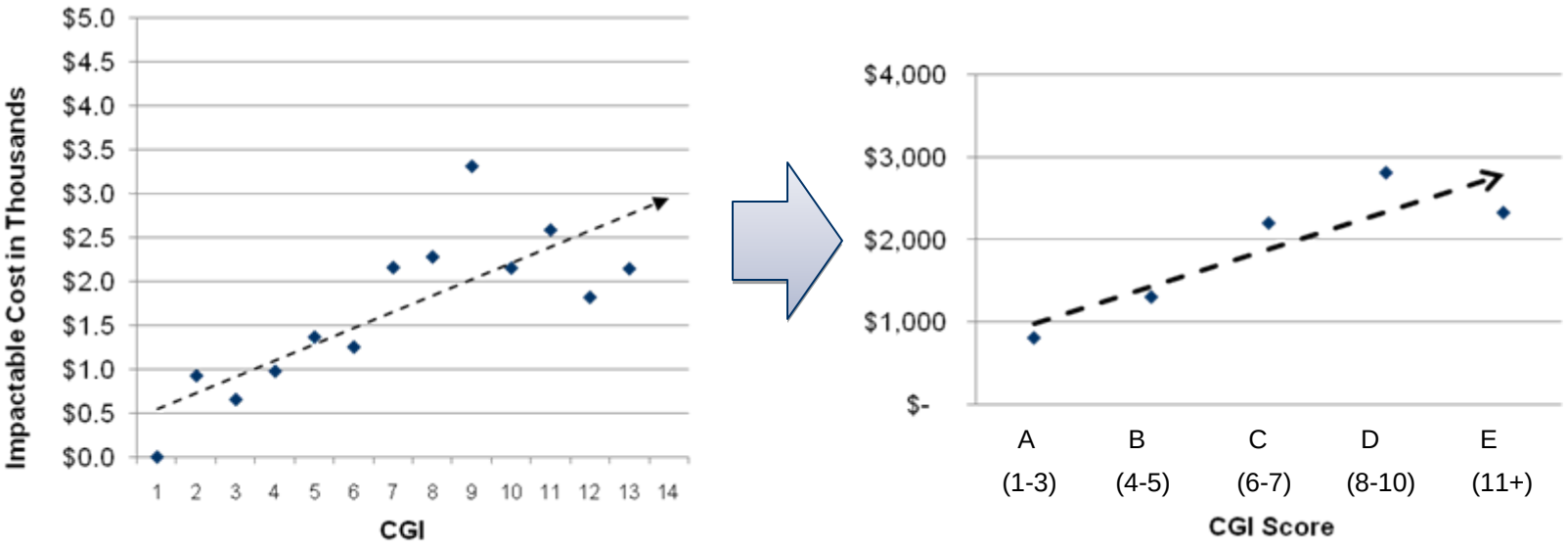
# Overall CGI and Cost within each RI Bucket




**In the example shown, we have used the difference between the CGI score C and the Base Cost to illustrate the calculation of overall "impactable" cost**

# CGI and Cost for RI Bucket 1

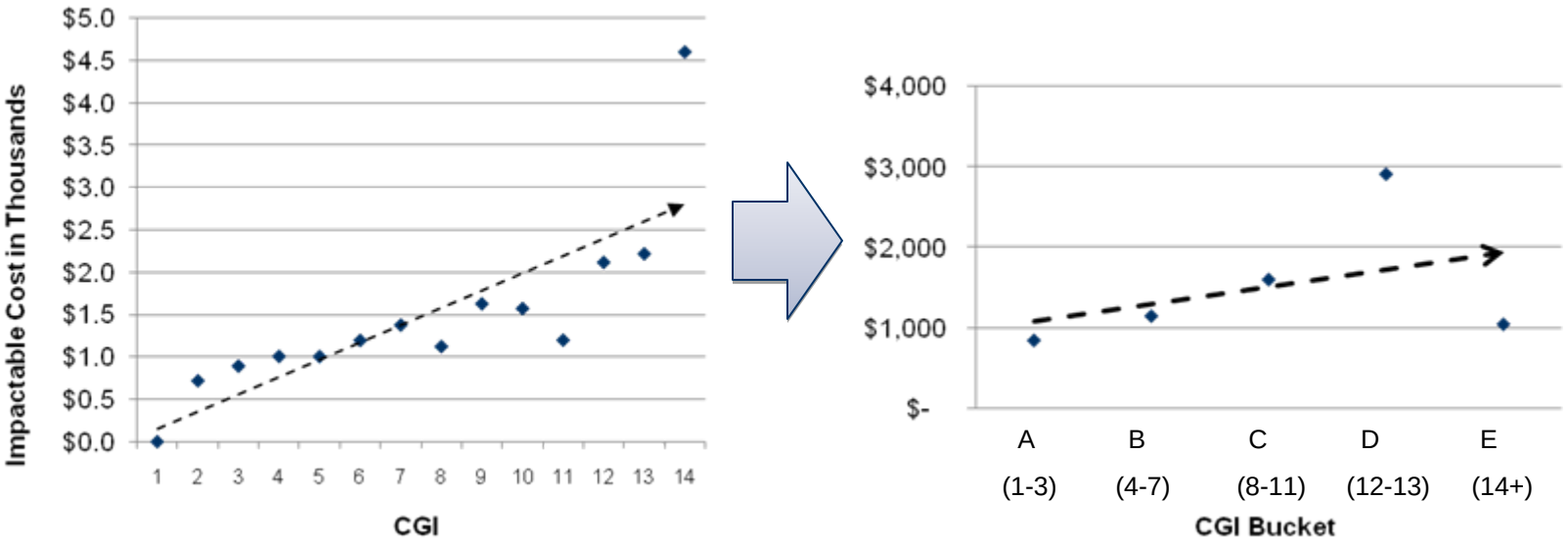
**RI Bucket 1**




- **Within this relatively healthy population (with a low Risk Index) that primarily requires predictable screening tests with well established economic (and clinical) benefit, the approach leads to a near linear relationship.**
- **R-squared for this relationship, without CGI grouping, is 0.83. With CGI grouping, it is 0.96**
- **Based on these findings, approximately $600 per individual per year could be saved by moving individuals to the next immediately adjacent (lower) CGI score**

# CGI and Cost for RI Bucket 2

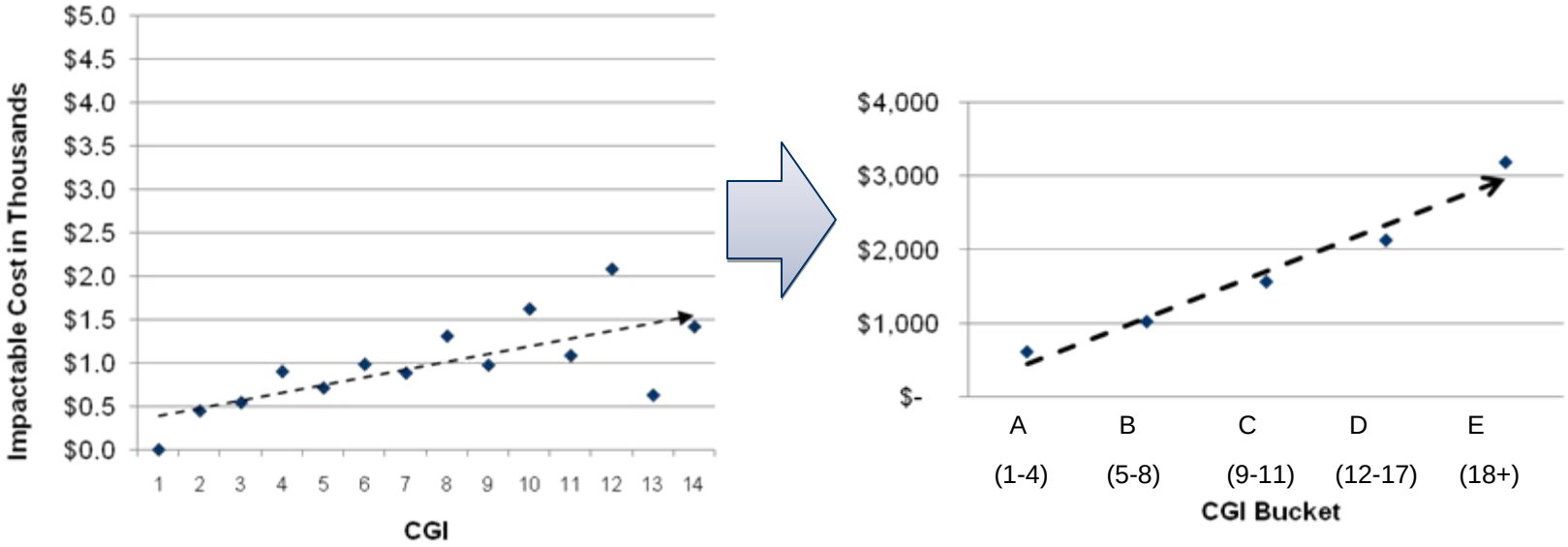
**RI Bucket=2**




- **Within this moderately diseased population (with a mid-range Risk Index) that requires screening tests and some risk factor reduction, the approach leads to a near linear relationship, until we reach the upper levels of CGI (14+)**
- **R-squared for this relationship, without CGI grouping, is 0.74. With CGI grouping, it is 0.52**
- **Based on these findings, approximately $500 per individual per year could be saved by moving individuals to the next immediately adjacent (lower) CGI score**

# CGI and Cost for RI Bucket 3

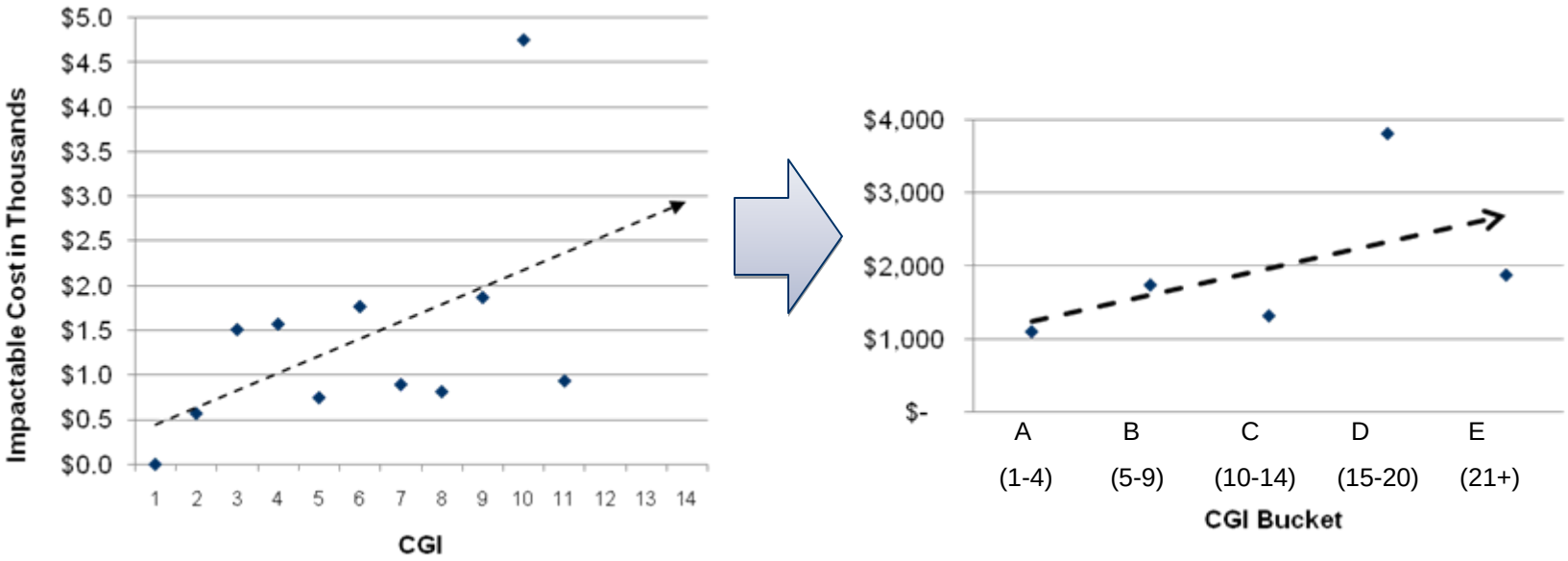
**RI Bucket=3**




- **Within this diseased population (with a mid-range Risk Index) that requires screening tests, and some monitoring and therapy, the approach again leads to a near linear relationship**
- **R-squared for this relationship, without CGI grouping, is 0.73. With CGI grouping, it is 0.97**
- **Based on these findings, approximately $600 per individual per year could be saved by moving individuals to the next immediately adjacent (lower) CGI score**

# CGI and Cost for RI Bucket 4

**RI Bucket=4**




- **Within this diseased population (with a upper to mid-range Risk Index) that often have complications and require additional monitoring and therapy, there is more inconsistency and a less linear relationship**
- **R-squared for this relationship, without CGI grouping, is 0.30. With CGI grouping, it is 0.56**
- **Based on these findings, approximately $700 per individual per year could be saved by moving individuals to the next immediately adjacent (lower) CGI score**

# Conclusions

- **Our work to date demonstrates that there is a quantifiable cost associated with care gaps that exist in a commercially insured population**
- **The estimated value of these gaps has been evaluated over a 12 month period**
- **The value of closing care gaps depends on the population segment, as the relative proportion of different care gap types (screening, chronic disease diagnosis and monitoring, chronic disease therapy) varies**
- **Additional study is needed to evaluate a longer follow-up time period (24 or 36 months) and to specifically track the performance of individual patients and cohorts as they move between CGI scores**

Thanks for your time and attention!

# Appendix

# Key Findings from Risk Model Analysis

1) The D2 Longitudinal Database has been rigorously evaluated for group level cost prediction (size now 11M).

2) The Risk Index (RI) predicts PMPY cost (over the next 12 months) with high accuracy for large groups.

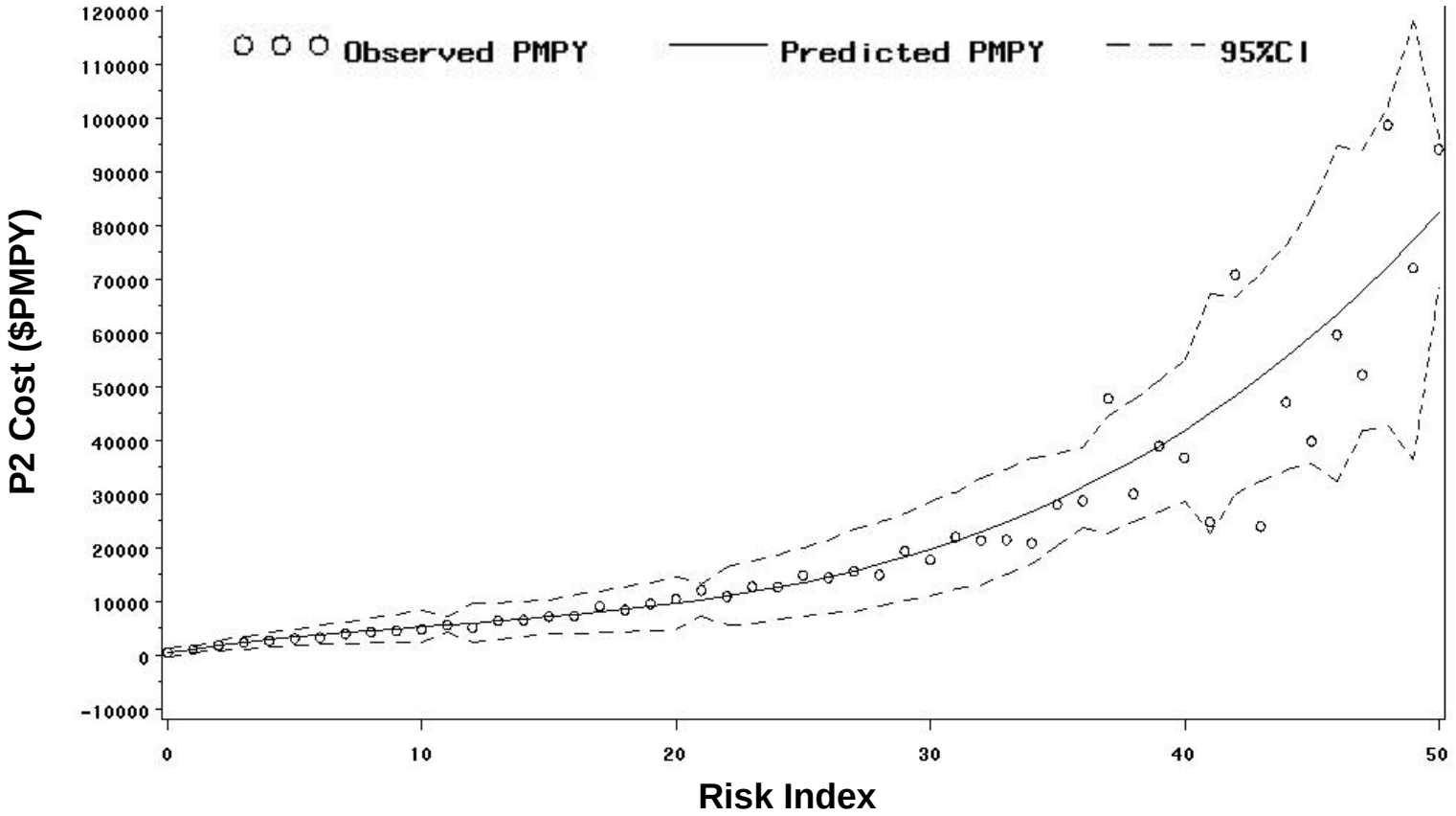
3) We have now defined the short term (next 12 months) amount of potentially “impactable” cost for various segments of the patient population

# Key Finding 1: RI Group Level Prediction

- **Divided the random sample of the norm dataset into 2 halves**
- **Used a linear regression model to evaluate the association between average P2 cost and RI for the first half (D2 Norm$^{A}$)**
- **Used regression coefficients from this to predict P2 cost for the second half (D2 Norm$^{B}$) and compared this prediction with the actual observed values, producing:**
  - $R^2 = 0.88$
  - Mean Absolute Prediction Error (MAPE) = 43%

# Key Finding 1: RI's Group Level Prediction is Accurate

***RI Group Level Prediction based on RI-defined Groups***

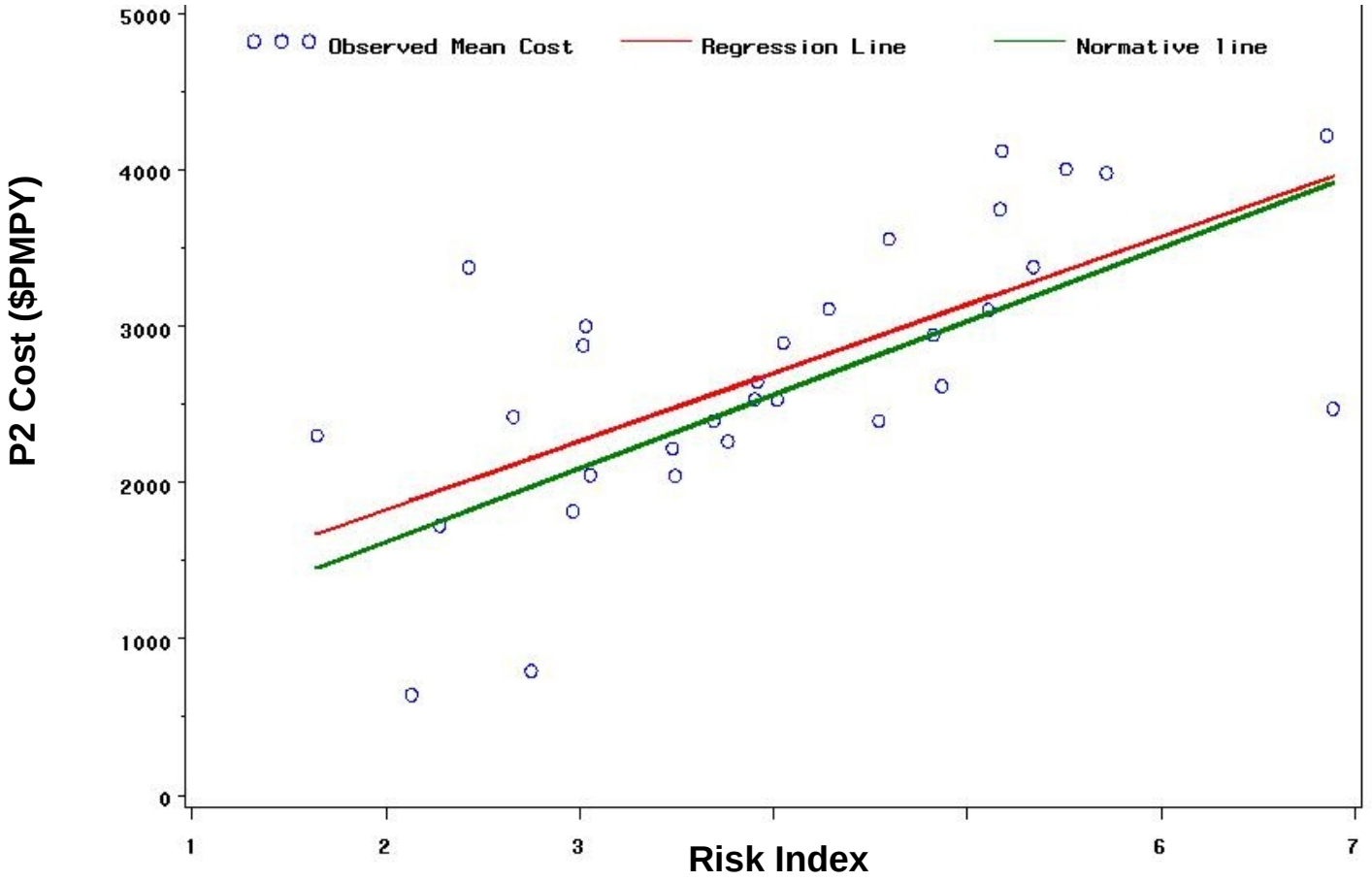



RI's group level prediction, with groups defined by their RI score, is accurate:

- R2 = 0.88
- Mean Absolute Prediction Error (MAPE) = 43%

# Key Finding 2: RI's Group Level Prediction using "Real-World" Employer Groups

***Comparison of Groups defined by RI and "Real-World" Employer Groups***




The slopes of the two regression lines displayed are within 7% of each other