Using Actuarial Methods to Minimize Chronic Disease

2016 Predictive Modeling Summit

Ella Young

Decision Support

Vancouver Coastal Health

The Goal

- Make the plethora of health data actionable so
  - patients are healthier,
  - providers are happier, and
  - costs are lower

Vancouver CoastalHealth
Promoting wellness. Ensuring care.

Steps to Achieve the Goal

- Exploratory Analysis
- Modeling – does it matter?
  - Prediction - general term, independent of time
  - Forecasting - prediction with time as a one of the dependent variables
  - Projecting - forecasting the predictable component of the series into the future
- Modeling – 2 examples
  - Workers' Comp
  - Healthcare

Exploratory Analysis

- Appropriately weight relative risk factors to predict future expected events
- Step 1
  - Who?   What common characteristics?
  - What are the implications of those characteristics?
- Step 2
  - *scarce* **resource allocation for maximum ROI**
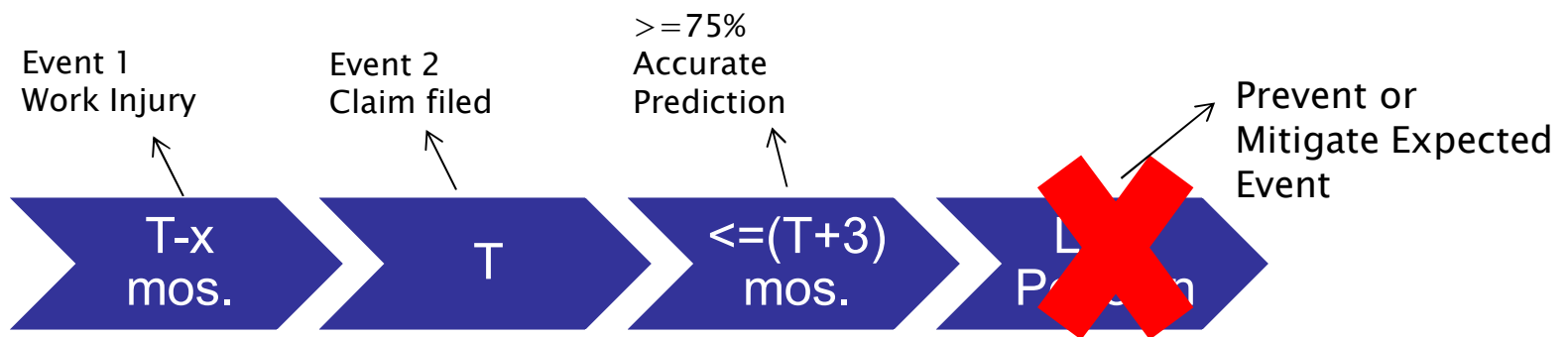 - Who is *intervenable* or *impactable*?

Geographic Context

- **Capital city:** Victoria on Vancouver Island
- **Population:** 4.5 million (Vancouver - 2.3 million, Victoria - 368,000)
- Canada's 3rd most populated province (after Ontario/Quebec)
- **History:** Entered Canadian confederation in 1871
- **Total Area:** 944,735km^2/364,764mi^2 (50% bigger than Texas)
- **Highest Point:** Fairweather Mtn, 4,663m/15,299ft
- **Lowest Point:** Pacific Ocean, sea level

Example 1 - WorkSafe BC

- $1 B public workers' compensation insurance
  - Non-profit/Universal-ish for BC workers
- In-house rehab and claims management services
- New data warehouse
- But:
  - Traditional claims management model
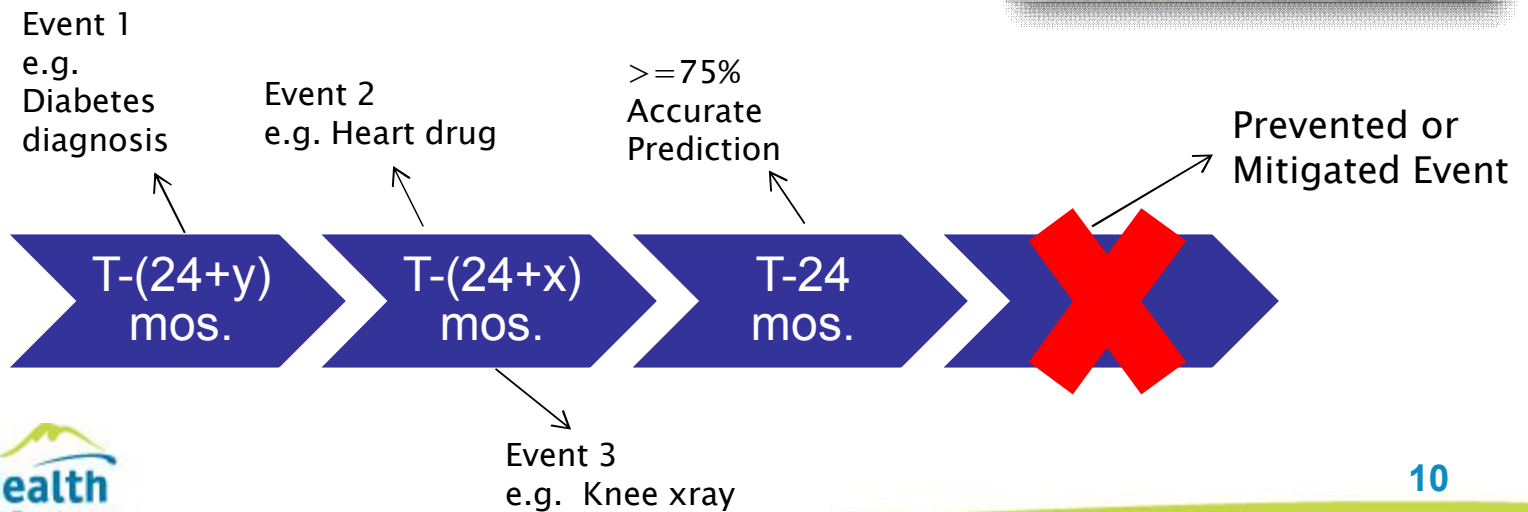 - Traditional data analysis

WCB Model Objective

Event 1
Work Injury

Event 2
Claim filed

>=75%
Accurate
Prediction

Prevent or
Mitigate Expected
Event

T-x mos.	T	<=(T+3) mos.	L... P...m

Vancouver CoastalHealth
Promoting wellness. Ensuring care.

WCB Results

- **Published in Interfaces: Early Detection of High-Risk Claims at the Workers' Compensation Board of British Columbia**

- decision-analysis and logistic-regression approach
  - decision analysis used to develop a classification rule with high out-of-sample predictive power
  - logistic regression models for injury type/age strata/workdays
- Implemented in a claims-profiling scorecard, which identifies claims needing early intervention in the claims management system
- High-risk claims are extremely costly
- The model saves about $5 M annually

BC Ministry of Health

- $16 B Public health insurer
  - Non-profit/Universal
- Data rich - many decades on almost all citizens (approx. 18 M lives)
- Analysis skill-set variation
- Traditional BI tools

BC MOH Model Objective

Event 1
e.g.
Diabetes
diagnosis

Event 2
e.g. Heart drug

>=75%
Accurate
Prediction

Prevented or
Mitigated Event

| T-(24+y) mos. | T-(24+x) mos. | T-24 mos. | ✗ |

Event 3
e.g. Knee xray

What is Heart Failure ?

- the **inability of the heart to pump blood** to meet the oxygenation and nutritional needs of the tissues, with multiple systems affected and participating in the dysfunction - more than just a weak pump

- can result from any structural or functional cardiac disorder that impairs the ability of the ventricle(s) to fill with or eject blood and can occur suddenly or slowly over a period of time

- can reduce the quality and length of life and can lead to frequent hospitalizations

- affects men and women equally. **Women** tend to be **older** with a history of **hypertension** (HTN) when first diagnosed; **men** tend to be younger at onset and have a history of **coronary artery disease (CAD)**

- Common with age, so incidence and prevalence is expected to increase

- annual mortality anywhere from 5% to 50%, depending on the severity of the dysfunction and associated symptoms (ie. pulmonary edema) along with other factors (ie.co-morbidities)

- is a syndrome - a group of symptoms that collectively indicate or characterize a disease or other abnormal condition

- associated with numerous symptoms and causes so many ways a person may present. It continues to be a syndrome that is **difficult to diagnosis and treat effectively**
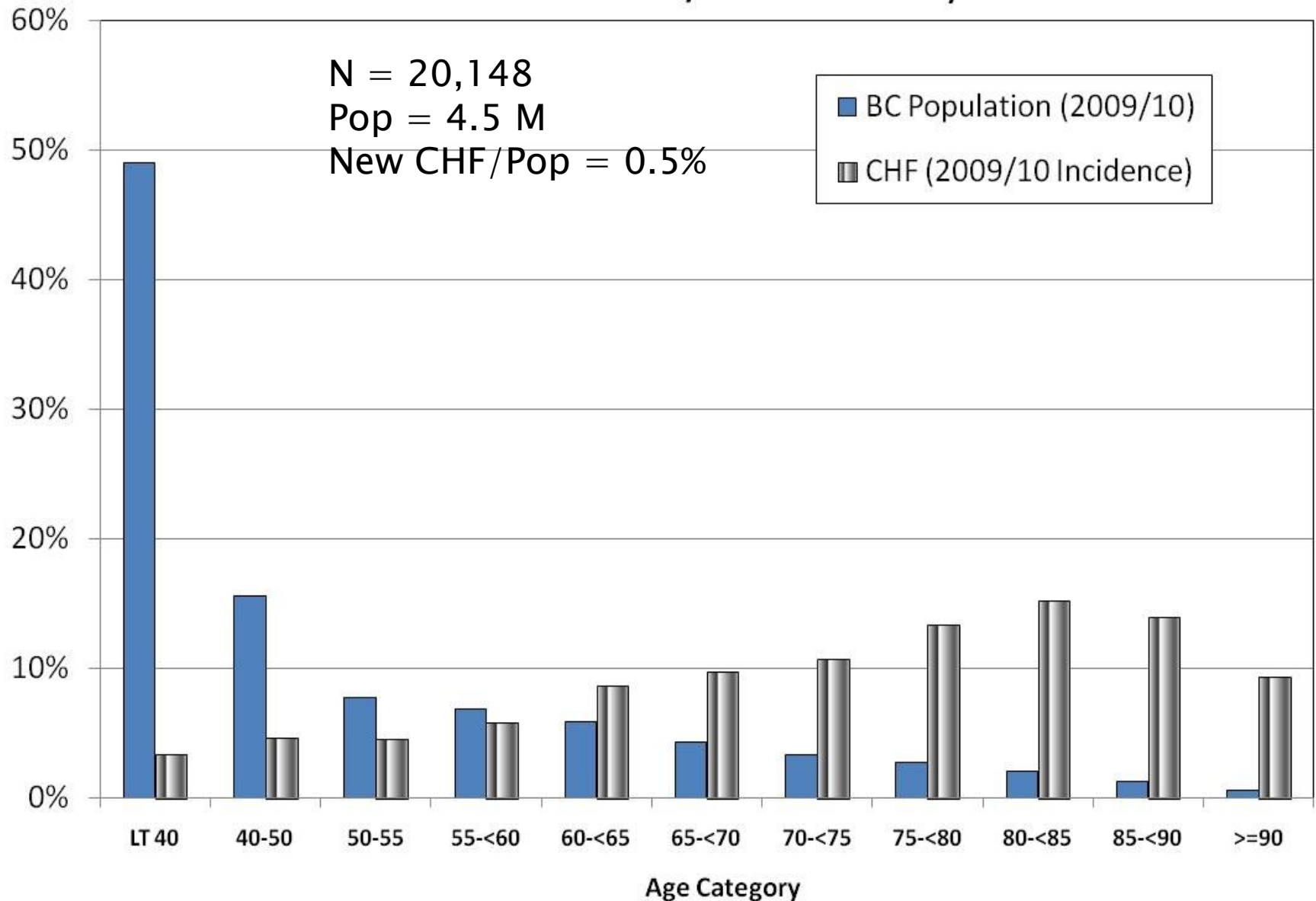
Not Fun…

Vancouver
Coastal**Health**
Promoting wellness. Ensuring care.

BC Heart Failure Statistics

- The 90,000 HF patients in BC cost $600 M/year
 - Hospital ~$340 M
  - MSP ~$150 M
  - Pharmacare ~$102 M
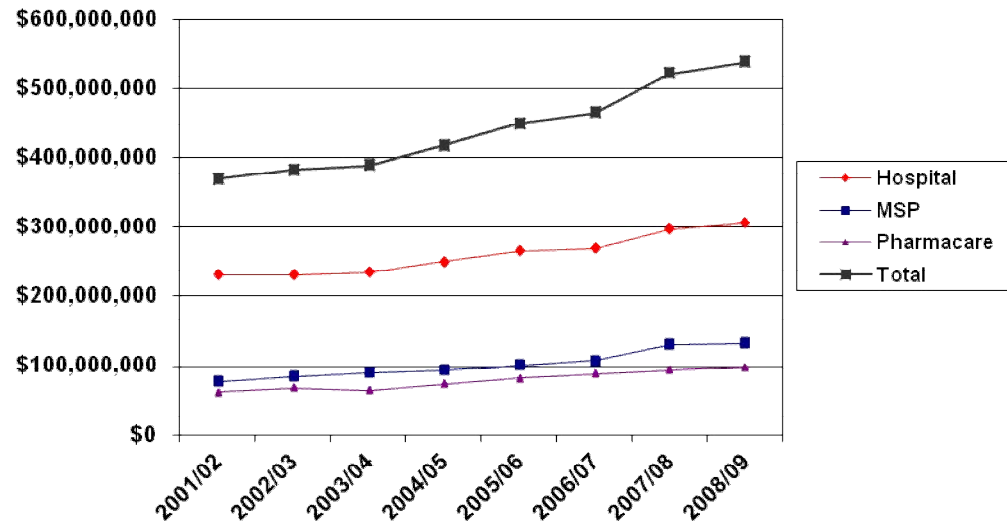
- HF is the most common cause of hospitalization of people > 65 years of age

- Average 1 year mortality rate of 33%, 4 year = 40%, 5 year = 50%

- Improved management can avoid 50% of inpatient HF related admissions

- In 2009, HF clinics provided service to 1.5% of HF patients

Comparison of 2009/2010 BC Population and CHF Patients (with Incidence Date in 2009/2010 Fiscal Year)

N = 20,148
Pop = 4.5 M
New CHF/Pop = 0.5%

Legend: BC Population (2009/10), CHF (2009/10 Incidence)

Age Category: LT 40, 40-50, 50-55, 55-<60, 60-<65, 65-<70, 70-<75, 75-<80, 80-<85, 85-<90, >=90

Pre-HF Chronic Conditions of the 09/10 HF Incident Cohort

% of HF patients with another select Chronic Disease

Average incidence time versus HF (years)
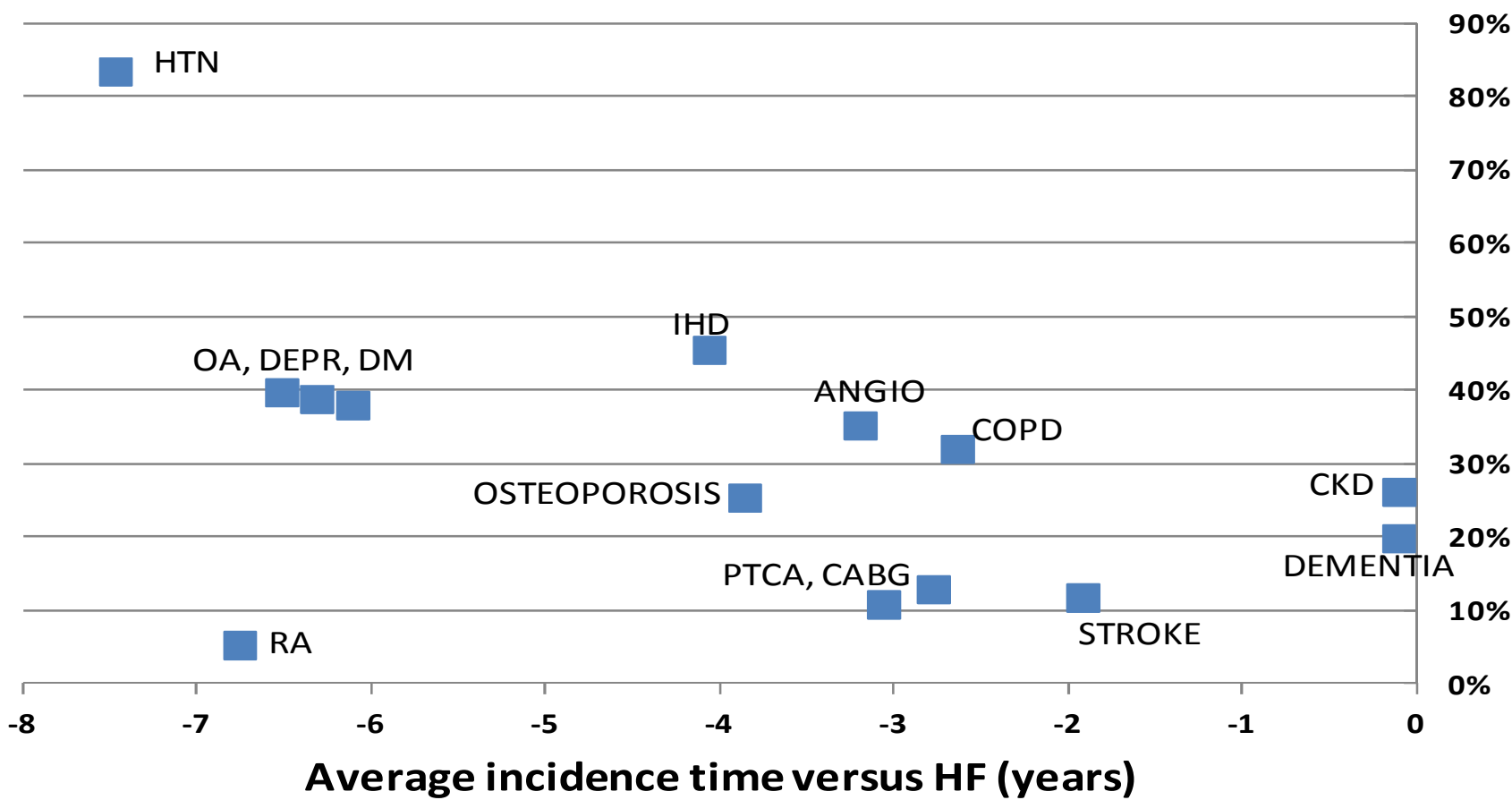
Preliminary Findings – No Surprises

- Membership in chronic disease registries and lab tests are important
- Of approx. 800 initial variables, about 15 remain (depending on strata)
- Decision trees and path analysis found 100 significant variables from the 800

- Of the General Linear Models, discriminant analysis did the best - it achieved a classification rate of about 70% for age groups of interest
- Neural network modeling was next at about 65-71% classification rate
- Logistic regression resulted in a 60-65% classification rate

- Survival analysis achieves the best result
  - Over 9 years, it finds about 85% of 45+ year-old who became HF incident

Modeling is not…

It's the data and the methods, BUT…

Global Average Temperature Vs. Number of Pirates
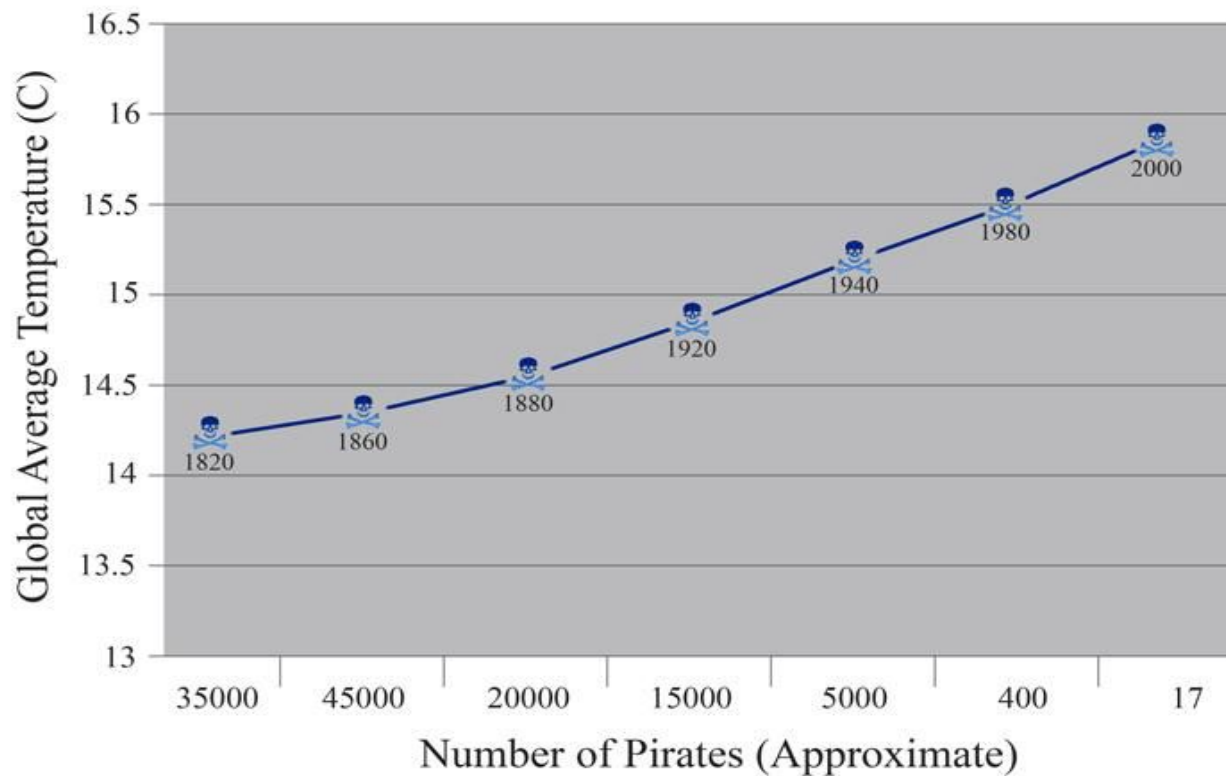
- The # of pirates has decreased since 1860

- The globe has been warming

- Thus, Somalia is saving the planet

- Really ???

It's Really the Skillset

- Know how to 'listen' to the data, which is at the heart of the actuarial approach

- per Lisi (2011):

  "Humans are terrible at dealing with probability. We are not merely bad at it, but seem hardwired to be incompetent, in spite of the fact that we encounter innumerable circumstances every day which depend on accurate probabilistic calculations for our wellbeing… This blind spot in our collective consciousness – the inability to deal with probability – may seem insignificant, but it has dire practical consequences."

VCH - Where we are
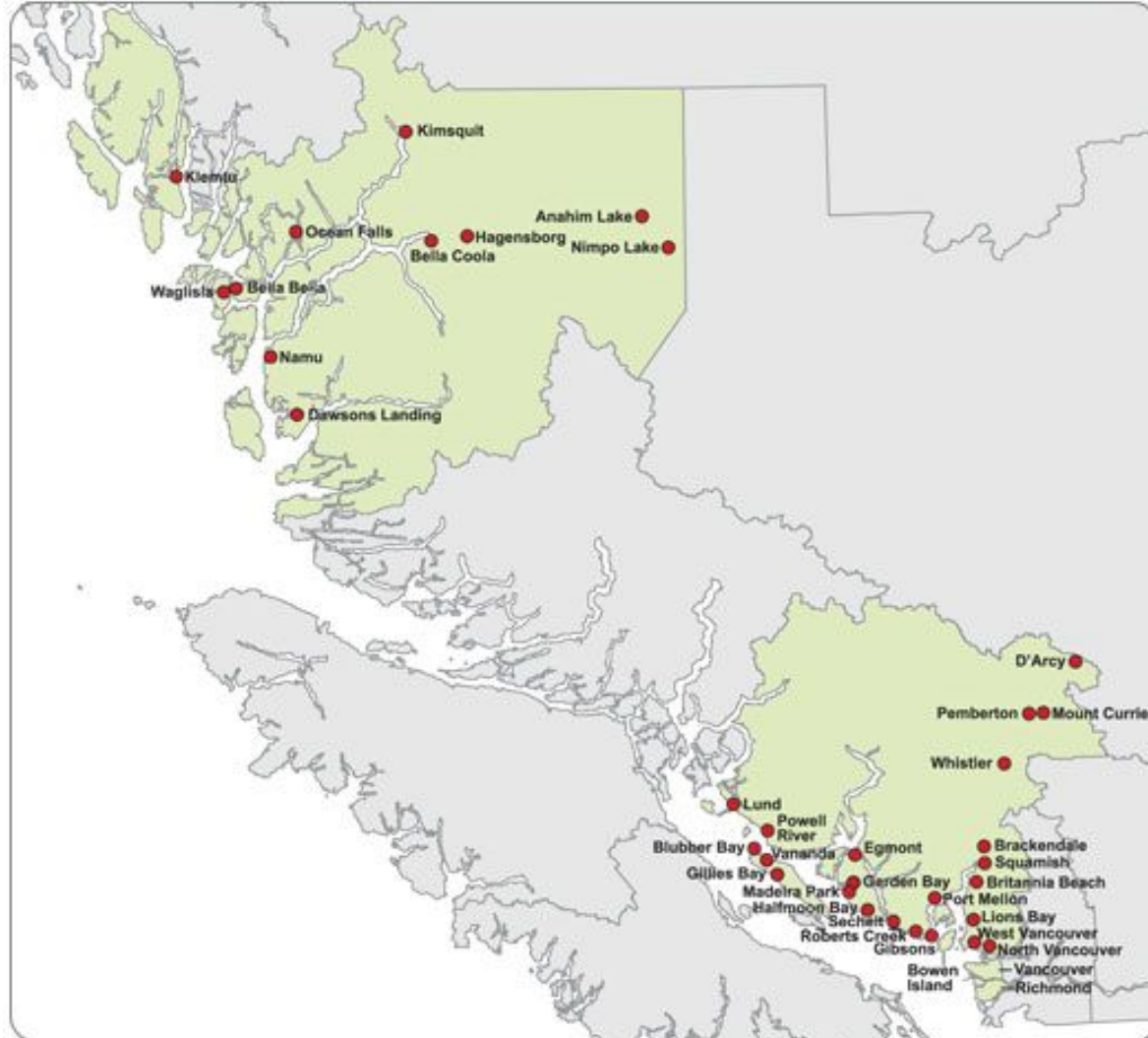
VCH - Who we serve

- **25% of BC's population (> 1 M)**

- **22,000 staff, 2,500 physicians and 5,000 volunteers**

- **556 locations including;**
  - **13 hospitals**
  - **3 diagnostic/treatment centres**
  - **15 community health centres**

- **46% of all inpatient specialized care in BC**

- **58,560 km2 (22,610 mi2) including;**
  - **12 municipalities, 4 regional districts and 14 Aboriginal communities**

- **We operate:**
  - **8,936 acute, rehabilitation and residential beds**
  - **421 community residential care beds**
  - **621 assisted living beds/units**
  - **1,430 mental health supported housing units**
  - **2,447 mental health beds**
  - **1,312 addictions beds**

Vancouver CoastalHealth
*Promoting wellness. Ensuring care.*

Next Steps

- Identify VCH citizens at high risk of HF incidence and communicate them with providers

- Work with Primary Care/GPSC/BC HF SC to provide evidence-based care for those identified, by strata and interest

- Conduct control matched evaluation

What do we hope to achieve?

- To promote *proactive monitoring for* HF in the community with a case finding approach and registry

- To improve the *care pathway* of high-risk patients for HF through the GPs office

- Develop relationships and *shared care plans* amongst family physicians, patients, specialists and acute care / community services

- To promote and encourage *optimal management* of HF according to national guidelines

Beyond the Horizon

Risk Factors - from Big Data Sources
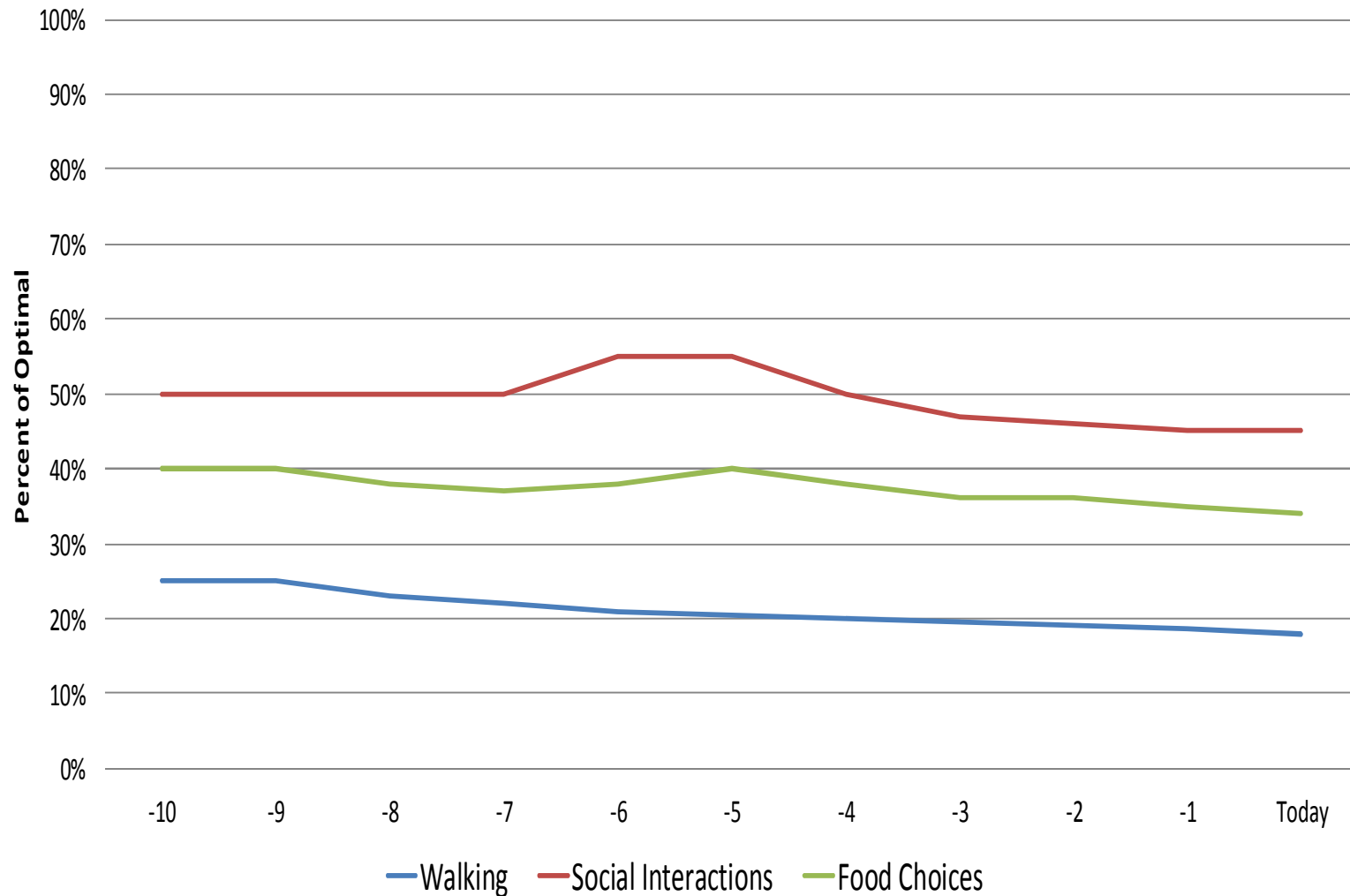
Enabling Actionable Conversations with Impactable Patients

Patient X's Expected Future - Re Diabetes for example
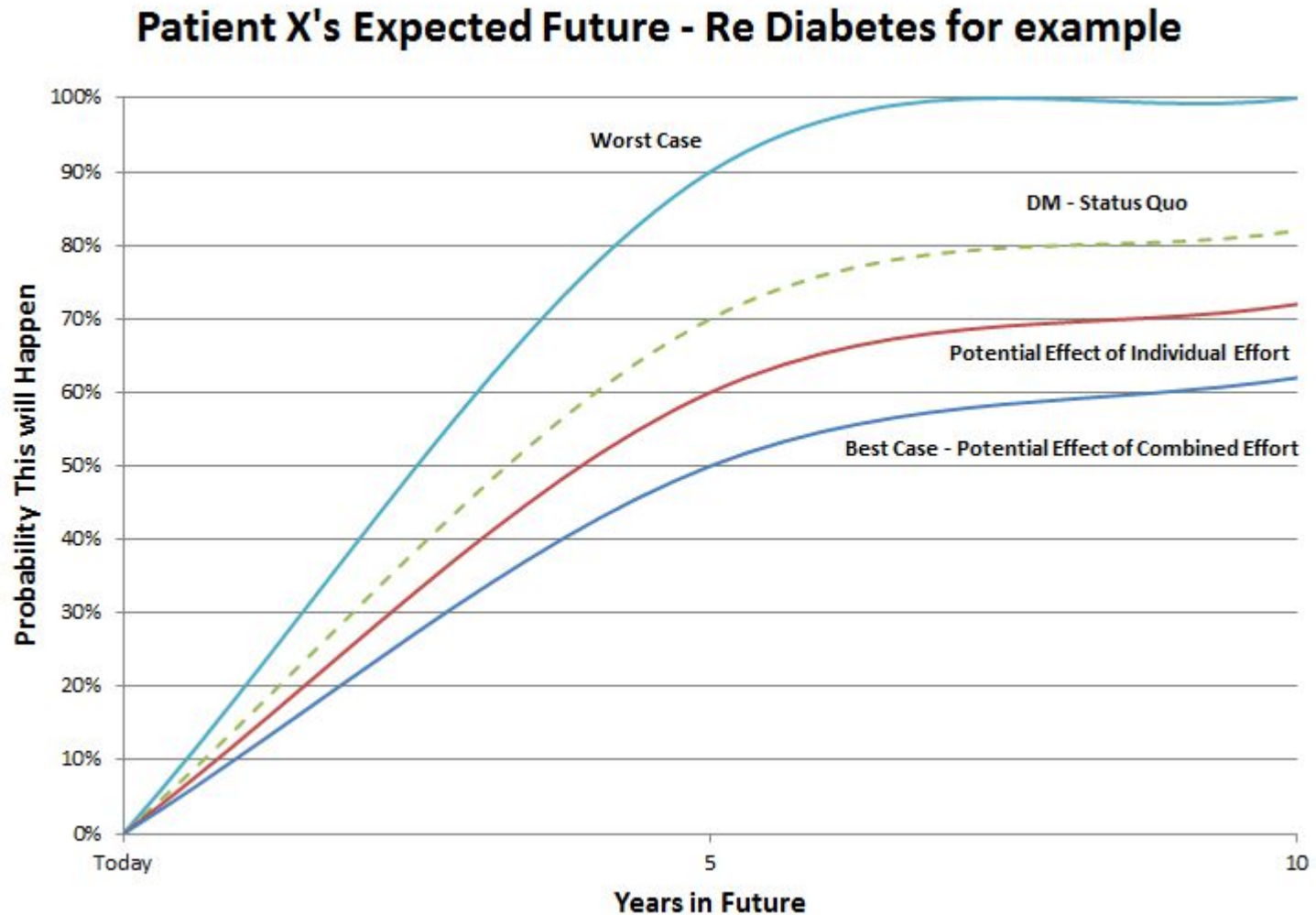
Possible Clinical Next Steps

The Healthy Living Partnerships to Prevent Diabetes Study: 2-Year Outcomes of a Randomized Controlled Trial

Jeffrey A. Katula, PhD, MA et. Al. NC

American Journal of Preventive Medicine, Volume 44, Issue 4, Supplement 4, p. S324-S332, April 2013

Results
Intent-to-treat analyses of between-group differences in the average of 18- and 24-month measures of outcomes (controlling for baseline values) revealed that the LWL participants experienced greater decreases in fasting glucose (−4.35 mg/dL); insulin (−3.01 μU/ml); insulin resistance (−0.97); body weight (−4.19 kg); waist circumference (−3.23 cm); and BMI (−1.40), all *p*-values <0.01.

Conclusions
A diabetes prevention program administered through an existing community-based system and delivered by community health workers is effective at inducing significant long-term reductions in metabolic indicators and adiposity.

Physician Profile Report

Family doctor central to chronic care, Manitoba study says

Most chronic care patients in Manitoba receive care from their regular family doctors, a study this week from the Manitoba Centre for Health Policy (MCHP) says. Four of every five visits for care are provided by the regular doctor,

however many referrals to specialists are not made by a person's main family doctor, but by another family doctor.

Dr. Alan Katz, lead author of the study, says further study is needed to explain patterns of care provided by non-assigned primary care doctors.
"This is at odds with medical evidence that an ongoing doctor-patient relationship is best for health outcomes."

205 9000000200 Last, First 9000000200   91   F   4 10% 93%   4   Y   Y   Y   Y

Understanding the Patterns of Ambulatory Care in Manitoba, Katz A, Martens et. Al., March 2013.

Q & A

Thanks for your feedback!