



SCHOOL OF PUBLIC HEALTH  
UNIVERSITY *of* WASHINGTON

# Challenges measuring healthcare costs attributable to an individual chronic condition

Steve Zeliadt, PhD MPH  
Seattle-Denver VA HSR&D Center of Innovation

HERC Health Economics Cyberseminar  
October 16, 2013

IIR 07-235/Zhou “Modeling of Health Care Costs (MHCC) of Veterans with Chronic Diseases”



# Today's goals

After this session you should be able to:

- Describe causality in the context of costs
- Know different approaches that have been used to estimate attributable costs in cross sectional administrative data
- Understand challenges with cost-attribution problem
- Be skeptical when you read “condition \_\_\_\_\_ costs XXX billions of dollars”

# General Causal Framework

Exposure  Outcome

Smoking  Lung cancer

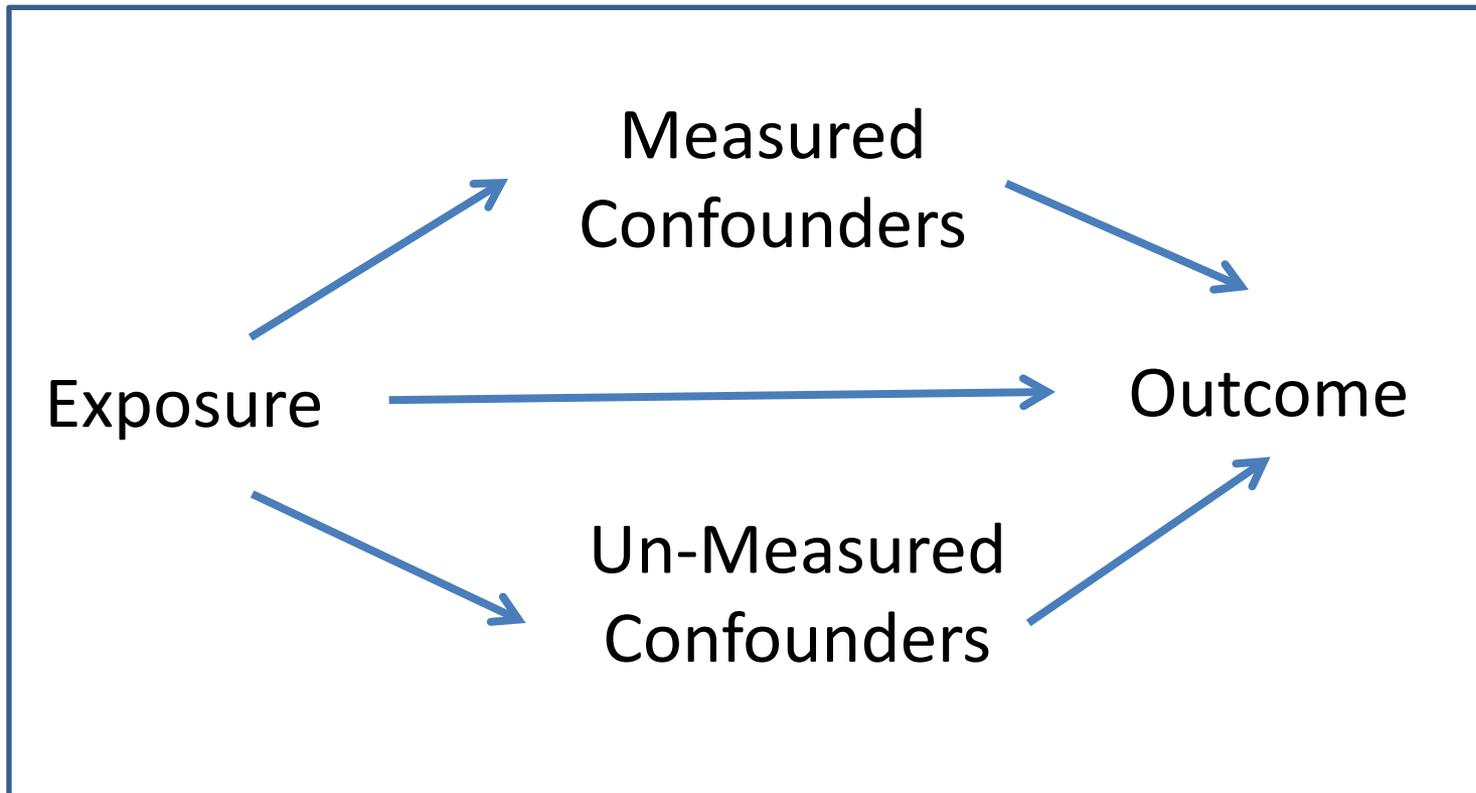
Calcium deficiency  Fracture

Pregnancy  Health care utilization

Condition X  Medical costs



## Complex in reality...





# Attributable Cost

- Examples from literature:
  - “Cancer costs are \$125 billion dollars.”
  - “Incremental costs of care for individuals with X compared with those without X.”
  - “The proportion of total U.S. health care costs attributable to X.”
  - “The Institute of Medicine reported that the economic cost of X was \$45 billion.”
  - “Condition X impacts 55 million adults and costs X annually.”
  - “The American Diabetic Association reported that diabetes cost \$116 million in excess medical expenditures.”
- Imply causality – counterfactual is cost without condition X
  - If we cured cancer, would we save \$125 billion dollars?



# Poll Question

- What is the audience's interest in measuring costs & causality?
  - I have written at least one paper on the attributable cost of an important condition.
  - I've never measured attributable costs directly, but I plan to.
  - I just want to know so I can write in the first paragraph of my grant that the cost of \_\_\_\_\_ is XXX billion.
  - I haven't thought much about attributable cost before.



# Approaches using claims

- Sum all
- Sum primary



## Direct and Indirect Economic Costs of Illness by Major Diagnosis, U.S., 2009

Diagnosis	Amount (Dollars in Billions)			Percent Distribution		
	Direct Cost*	Indirect Cost of Mortality**	Total	Direct Cost	Indirect Cost of Mortality	Total
Cardiovascular Diseases	\$192.1	\$120.5	\$312.6	15.2%	20.0%	16.8%
COPD, Asthma, Pneumonia	81.5	24.6	106.1	6.5	4.1	5.7
Anemias	4.7	1.2	5.8	0.4	0.2	0.3
<b>Subtotal</b>	<b>278.2</b>	<b>146.2</b>	<b>424.4</b>	<b>22.1</b>	<b>24.3</b>	<b>22.8</b>
Neoplasms	86.6	130.0	216.6	6.9	21.6	11.6
Injury and Poisoning	83.2	95.9	179.1	6.6	15.9	9.6
Endocrine, Nutritional, and Metabolic Diseases	110.9	23.5	134.4	8.8	3.9	7.2
Diseases of the Digestive System	85.2	29.2	114.5	6.8	4.9	6.1
Diseases of the Respiratory System†	97.7	31.7	129.4	7.8	5.3	6.9
Diseases of the Musculoskeletal System	125.0	3.1	128.1	9.9	0.5	6.9
Diseases of the Nervous System	78.3	16.0	94.3	6.2	2.6	5.1
Mental Disorders	79.8	8.1	87.9	6.3	1.3	4.7
Diseases of the Genitourinary System	66.6	8.2	74.8	5.3	1.4	4.0
Infectious and Parasitic Diseases	22.3	23.9	46.2	1.8	4.0	2.5
Normal Live Birth	33.4	—	33.4	2.7	—	1.8
Diseases of the Skin	22.7	0.8	23.5	1.8	0.1	1.3
Other and Not Linked to Specific Condition	171.5	110.7	282.1	13.6	18.4	15.1
<b>Total</b>	<b>\$1,260.0</b>	<b>\$602.8</b>	<b>\$1,862.8</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

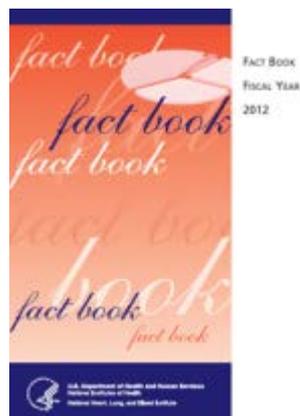
\* Direct costs are personal health care expenditures for hospital and professional services care, prescribed medications, and home care reported by the Medical Expenditure Panel Survey (MEPS), Agency for Healthcare Research and Quality (AHRQ), by diagnosis, excluding nursing home care costs and costs due to comorbidities.

\*\* The mortality cost for each disease group was estimated for 2009 by multiplying the number of deaths by age, sex, and cause of death in 2009 by the 2009 present value of lifetime earnings discounted at 3 percent.

† Includes costs for COPD, asthma, and pneumonia.

Note: Estimates are not available for total lung diseases and blood clotting disorders.

Source: Prepared by NHLBI from direct costs on the MEPS Web site; numbers of deaths from Vital Statistics of the United States, NCHS; present value of lifetime earnings from the Institute for Health and Aging, University of California. Total direct cost obtained from MEP Statistical Brief #355, National Health Care Expenses in the U.S. Civilian Noninstitutionalized Population, 2009.





### Direct and Indirect Economic Costs of Illness by Major Diagnosis, U.S., 2009

Diagnosis	Amount (Dollars in Billions)			Percent Distribution		
	Direct Cost*	Indirect Cost of Mortality**	Total	Direct Cost	Indirect Cost of Mortality	Total
Cardiovascular Diseases	\$192.1	\$120.5	\$312.6	15.2%	20.0%	16.8%
COPD, Asthma, Pneumonia	81.5	24.6	106.1	6.5	4.1	5.7
Anemias	4.7	1.2	5.8	0.4	0.2	0.3
Subtotal	278.2	146.2	424.4	22.1	24.3	22.8
Neoplasms	86.6	130.0	216.6	6.9	21.6	11.6
Injury and Poisoning	83.2	95.9	179.1	6.6	15.9	9.6
Endocrine, Nutritional, and Metabolic Diseases	110.9	23.5	134.4	8.8	3.9	7.2
Diseases of the Digestive System	85.2	29.2	114.5	6.8	4.9	6.1
Diseases of the Respiratory System†	97.7	31.7	129.4	7.8	5.3	6.9
Diseases of the Musculoskeletal System	125.0	3.1	128.1	9.9	0.5	6.9
Diseases of the Nervous System	78.3	16.0	94.3	6.2	2.6	5.1
Mental Disorders	79.8	8.1	87.9	6.3	1.3	4.7
Diseases of the Genitourinary System	66.6	8.2	74.8	5.3	1.4	4.0
Infectious and Parasitic Diseases	22.3	23.9	46.2	1.8	4.0	2.5
Normal Live Birth	33.4	—	33.4	2.7	—	1.8
Diseases of the Skin	22.7	0.8	23.5	1.8	0.1	1.3
Other and Not Linked to Specific Condition	171.5	110.7	282.1	13.6	18.4	15.1
<b>Total</b>	<b>\$1,260.0</b>	<b>\$602.8</b>	<b>\$1,862.8</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

\* Direct costs are personal health care expenditures for hospital and professional services care, prescribed medications, and home care reported by the Medical Expenditure Panel Survey (MEPS), Agency for Healthcare Research and Quality (AHRQ), by diagnosis, excluding nursing home care costs and costs due to comorbidities.

\*\* The mortality cost for each disease group was estimated for 2009 by multiplying the number of deaths by age, sex, and cause of death in 2009 by the 2009 present value of lifetime earnings discounted at 3 percent.

† Includes costs for COPD, asthma, and pneumonia.

Note: Estimates are not available for total lung diseases and blood clotting disorders.

Source: Prepared by NHLBI from direct costs on the MEPS Web site; numbers of deaths from Vital Statistics of the United States, NCHS; present value of lifetime earnings from the Institute for Health and Aging, University of California. Total direct cost obtained from MEP Statistical Brief #355, National Health Care Expenses in the U.S. Civilian Noninstitutionalized Population, 2009.



# Approaches using accounting data

- Total costs per person

$$\text{COST}_{\text{WITH CONDITION X}}$$

- Matching

$$\text{COST}_{\text{WITH CONDITION X}} - \text{COST}_{\text{WITHOUT CONDITION X}} = \text{ATTRIBUTABLE COST or NET}$$

- Regression

$$\text{COST} = B_0 + \underline{B_{1(\text{Condition})}} + B_{X(\text{Confounders})} + e$$



## Example in VA

- FY2008
- 20% sample of VA users (n=996,869)
- Total DSS cost - \$7 billion (geographic adjustors)
  
- Selected 31 common conditions
  - CMS chronic conditions warehouse
  - Other VA priority conditions
  - Indicators using AHRQ's Clinical Classification Software



# 31 Conditions

- AIDS/HIV
- Alcohol dependence
- Arthritis
- Asthma
- Benign prostatic hyperplasia
- Cancer-Colorectal
- Cancer-Lung
- Cancer-Prostate
- Cancer-Other
- Chronic kidney disease
- Congestive heart failure
- Chronic obstructive pulmonary disorder (COPD)
- Dementia
- Depression
- Diabetes without complications
- Diabetes with complications
- Dyspepsia
- Erectile Dysfunction
- Hepatitis C
- Hypertension
- Ischemic heart disease
- Multiple sclerosis
- Osteoporosis
- Parkinson's disease
- Vascular disorders
- Psychoses
- Spinal cord injury
- Stroke
- Substance abuse
- Tuberculosis
- Traumatic brain injury



# Poll – which do you think is most expensive for VA?

- AIDS/HIV
- Alcohol dependence
- Arthritis
- Asthma
- Benign prostatic hyperplasia
- Cancer-Colorectal
- Cancer-Lung
- Cancer-Prostate
- Cancer-Other
- Chronic kidney disease
- Congestive heart failure
- Chronic obstructive pulmonary disorder (COPD)
- Dementia
- Depression
- Diabetes without complications
- Diabetes with complications
- Dyspepsia
- Erectile Dysfunction
- Hepatitis C
- Hypertension
- Ischemic heart disease
- Multiple sclerosis
- Osteoporosis
- Parkinson's disease
- Vascular disorders
- Psychoses
- Spinal cord injury
- Stroke
- Substance abuse
- Tuberculosis
- Traumatic brain injury
- Don't know
- Other

# Prevalence

Condition	N	Prevalence of Condition, %	Mean Age, Yrs
Overall	996,869	100%	63
None of the 31 conditions of interest	160,670	16.1%	56
Alcohol dependence	62,228	6.2%	55
Arthritis	162,269	16.3%	66
Benign prostatic hyperplasia	120,343	12.1%	72
Cancer-Prostate	51,786	5.2%	74
Cancer-Other	75,160	7.5%	69
Chronic kidney disease	53,095	5.3%	72
Chronic obstructive pulmonary disorder (COPD)	113,662	11.4%	68
Depression	171,724	17.2%	58
Diabetes without complications	256,341	25.7%	67
Diabetes with complications	72,530	7.3%	66
Dyspepsia	223,345	22.4%	65
Hypertension	546,777	54.8%	68
Ischemic heart disease	189,942	19.1%	72
Psychoses	178,660	17.9%	57
Spinal cord injury	1,923	0.2%	59



# Average Total Cost

Condition	FY2008 \$
Overall	7,039
None of the 31 conditions of interest	1,800
Alcohol dependence	16,551
Arthritis	10,190
Benign prostatic hyperplasia	9,569
Cancer-Prostate	9,376
Cancer-Other	16,249
Chronic kidney disease	23,762
Chronic obstructive pulmonary disorder (COPD)	14,961
Depression	13,587
Diabetes without complications	9,927
Diabetes with complications	15,740
Dyspepsia	11,902
Hypertension	8,573
Ischemic heart disease	10,597
Psychoses	13,726
Spinal cord injury	59,606

# Attributable Cost

Condition	Total	Matching	Regression1	RegressionM
Overall	7,039	-	-	
None of the 31 conditions of interest	1,800	-	-	
Alcohol dependence	16,551	10,045	9,437	4,318
Arthritis	10,190	3,719	3,187	1,789
Benign prostatic hyperplasia	9,569	3,145	3,073	1,458
Cancer-Prostate	9,376	2,738	1,980	1,532
Cancer-Other	16,249	10,015	9,537	6,954
Chronic kidney disease	23,762	17,929	16,491	11,311
Chronic obstructive pulmonary disorder (COPD)	14,961	9,008	8,240	4,331
Depression	13,587	8,034	7,147	2,516
Diabetes without complications	9,927	3,851	3,394	1,071
Diabetes with complications	15,740	9,171	8,048	4,028
Dyspepsia	11,902	6,273	5,921	3,245
Hypertension	8,573	3,507	3,487	657
Ischemic heart disease	10,597	4,625	4,720	1,292
Psychoses	13,726	8,254	6,915	3,342
Spinal cord injury	59,606	52,515	46,488	44,725

# Expenditures

Condition	Matching	Regression1	RegressionM
Overall	\$7.0 Billion		
None of the 31 conditions of interest	-	-	-
Alcohol dependence	625.1 million	587.2	268.7
Arthritis	603.5	517.2	290.2
Cancer-Prostate	141.8	102.5	79.3
Cancer-Other	752.7	716.8	522.7
Chronic kidney disease	952.0	875.6	600.5
Chronic obstructive pulmonary disorder (COPD)	1,023.8	936.6	492.3
Depression	1,379.6	1,227.4	432.0
Diabetes without complications	987.2	870.0	274.5
Diabetes with complications	665.2	583.8	292.1
Hypertension	1,917.7	1,906.8	359.4
Ischemic heart disease	878.4	896.5	245.4
Psychoses	1,474.6	1,235.5	597.0
Spinal cord injury	101.0	89.4	86.0
...			

# Expenditures

Condition	Matching	Regression1	RegressionM
Overall	\$7.0 Billion		
None of the 31 conditions of interest	-	-	-
Alcohol dependence	625.1 million	587.2	268.7
Arthritis	603.5	517.2	290.2
Cancer-Prostate	141.8	102.5	79.3
Cancer-Other	752.7	716.8	522.7
Chronic kidney disease	952.0	875.6	600.5
Chronic obstructive pulmonary disorder (COPD)	1,023.8	936.6	492.3
Depression	1,379.6	1,227.4	432.0
Diabetes without complications	987.2	870.0	274.5
Diabetes with complications	665.2	583.8	292.1
Hypertension	1,917.7	1,906.8	359.4
Ischemic heart disease	878.4	896.5	245.4
Psychoses	1,474.6	1,235.5	597.0
Spinal cord injury	101.0	89.4	86.0
...			
<b>Total</b>	<b>16.9 Billion</b>	<b>15.7 Billion</b>	<b>7.4 Billion</b>



# Interpretation

- Non-sense estimates are common
  - MEPS example “pain” = \$300 billion of 1.3 trillion total cost?
  - Cost NLBI conditions was nearly \$300 billion...
- Is it appropriate to conclude CKD is most expensive condition for VHA?
- Correlated conditions “absorb” potential attributable cost
  - IHD / hypertension
  - Causal pathway/clinical mechanism is not specified a priori
  - Heart disease → Depression or Depression → Heart disease



# Possible Improvements – Advancing Science of Costing

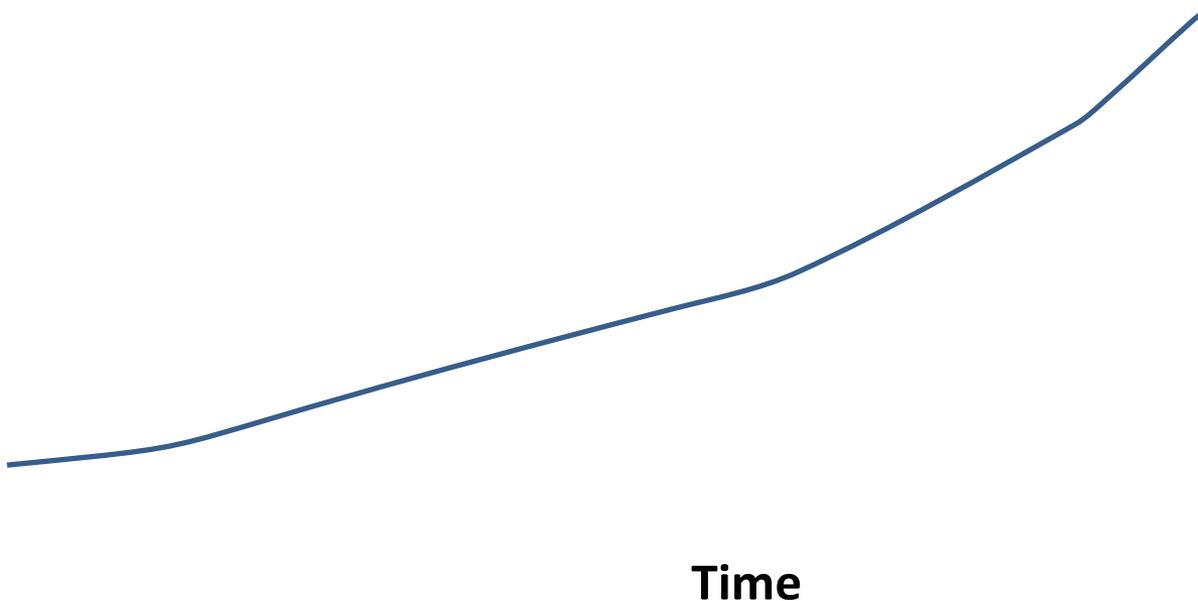
- Specify decision goal the cost model is to inform
- Parse in finer diagnostic categories
  - Clinical Classification Software 14,000 ICD9 codes → 285 mutually exclusive diagnosis groups
- Game theory/Shapely values
  - Starts with amount spent (top-down)
- Outline a priori clinical pathways/causal associations



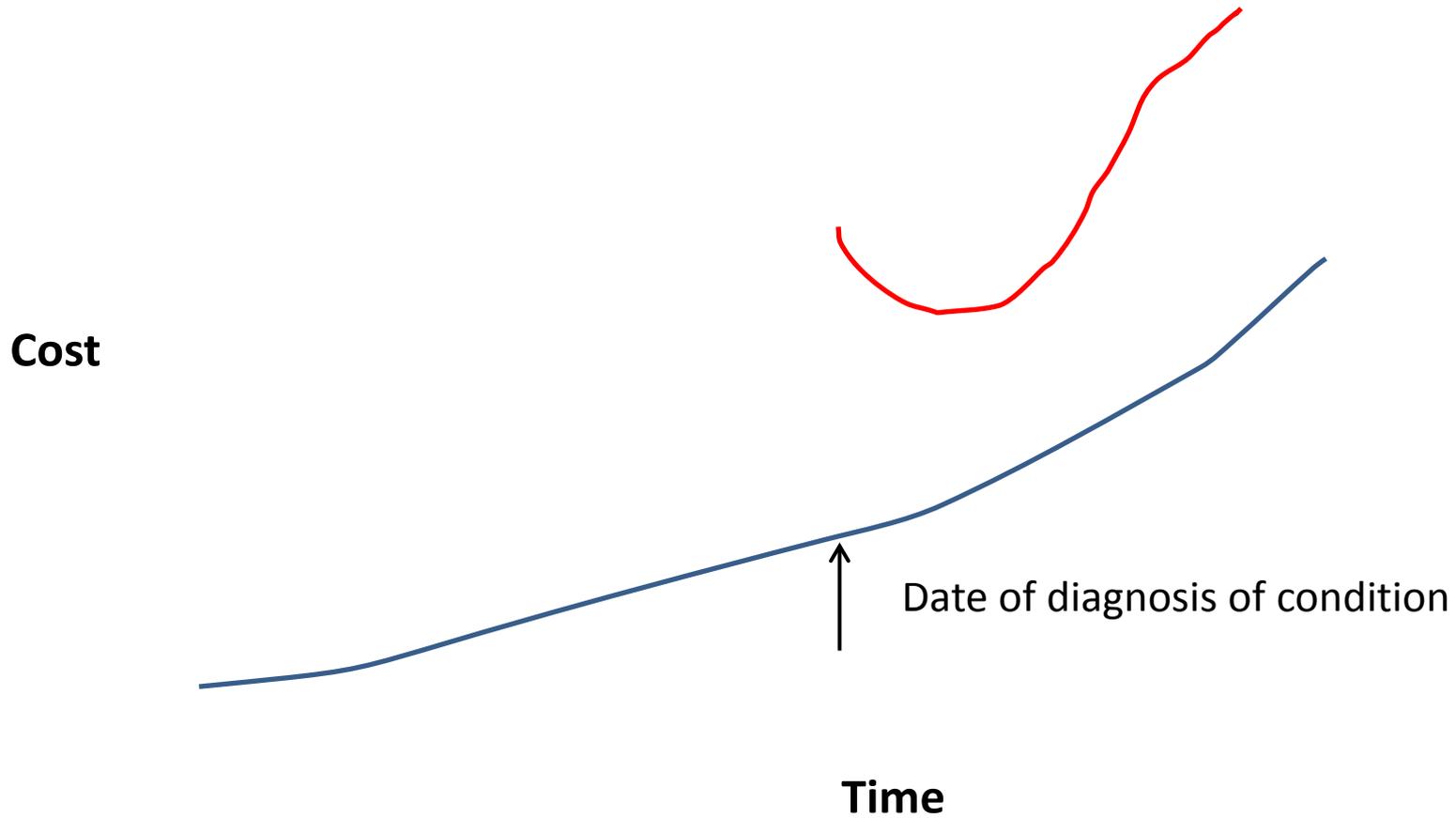
# Longitudinal/Time series analyses

- Longitudinal data strong foundation for causal associations
- Disease cost trajectory

**Cost**



# Onset of Condition



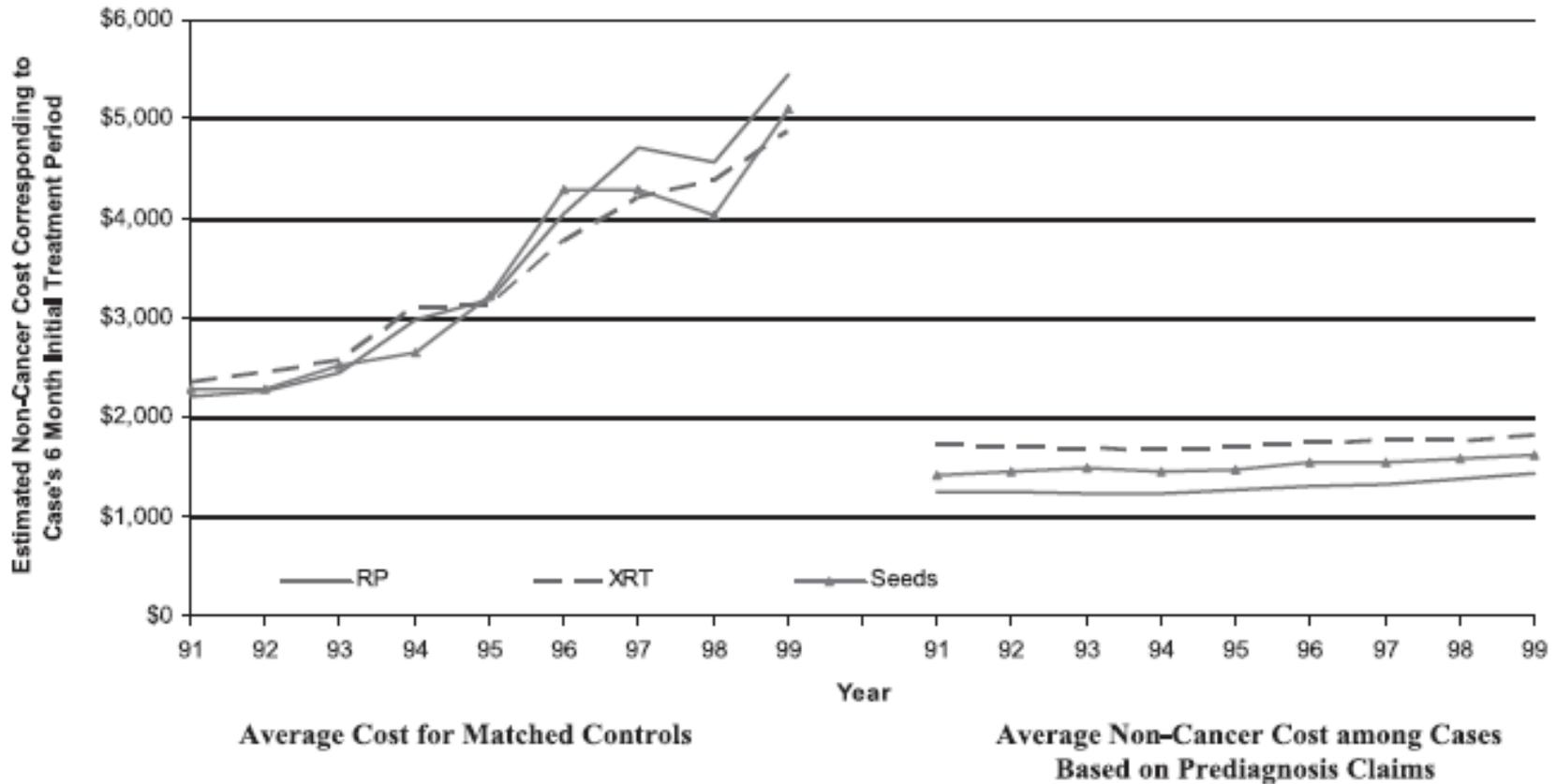


# Counterfactual

- If the subject had continued on their natural trajectory and not developed the condition of interest
- Historical data are increasingly available
  - Disease registries/onset information
  - Disease phase
  - Focus is on prediction model building vs hypothesis testing model

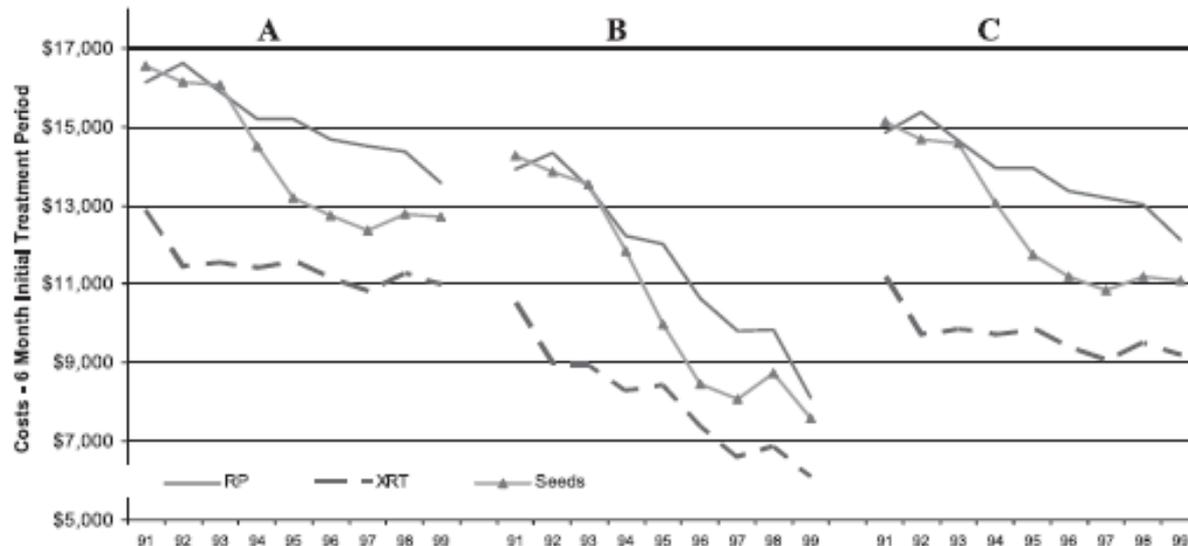


# Prostate cancer treatment example





# Healthy screener bias



**Cancer-Attributable Initial Treatment Costs by Year: Prediagnosis Method, \$**  
(corresponds to plot C)

	RP	XRT	Seeds
1991	14,866	11,172	15,137
1992	15,363	9,703	14,684
1993	14,658	9,826	14,567
1994	13,962	9,712	13,053
1995	13,943	9,847	11,730
1996	13,371	9,403	11,199
1997	13,184	9,045	10,830
1998	13,011	9,508	11,191
1999	12,135	9,182	11,088

A: Total costs

B: Cancer-attributable costs: Matched-control method

C: Cancer-attributable costs: Prediagnosis method

**FIGURE 1.** Total costs and cancer-attributable costs among cases stratified by initial treatment. A, total costs; B, cancer-attributable costs (matched control method); C, cancer-attributable costs (prediagnosis method).



# Discussion

- Use caution interpreting cross-sectional administrative estimates of attributable or “causal” costs
- OK statements:
  - “Expenditures among subjects with X condition were XXX”
  - “Expenditures among subjects with X condition were XXX above expected costs without X condition.” (included the counterfactual)
- Questions & ideas from the audience – How are you trying to estimate causal/attributable costs?