

**BME 301**  
**Practice Exam 1**  
**February 2, 2004**

**Name:** \_\_\_\_\_

The exam consists of 10 questions. Show all work to receive credit. Clearly organize your work and draw a box around your final answers. NEATNESS COUNTS! Good Luck!

Problem 1 (5): \_\_\_\_\_

Problem 2 (5): \_\_\_\_\_

Problem 3 (10): \_\_\_\_\_

Problem 4 (20): \_\_\_\_\_

Problem 5 (5): \_\_\_\_\_

Problem 6 (5): \_\_\_\_\_

Problem 7 (5): \_\_\_\_\_

Problem 8 (10): \_\_\_\_\_

Problem 9: (20): \_\_\_\_\_

Problem 10 (15): \_\_\_\_\_

Total (100): \_\_\_\_\_

1. Explain the difference between *incidence* and *prevalence* of a disease.

Incidence refers to new cases of a disease, while prevalence refers to existing cases of a disease:

Incidence rate = # new cases/population

Point prevalence = # of existing cases/population

2. What is a QALY? How much is our society willing to spend to gain one QALY?

A QALY is a quality-adjusted life year (a year of life saved, adjusted for the quality of health). Our society is currently willing to spend about \$100,000 to gain one QALY.

3. Lung cancer is the leading cause of cancer death for both men and women in the United States. More people die of lung cancer than of colon, breast, and prostate cancers combined. Lung cancer is fairly rare in people under the age of 40. The average age of people found to have lung cancer is 60. In 2004 there will be about 173,770 new cases of lung cancer in the United States. About 160,440 people will die of this disease. The population of the United States in 2004 is 292,287,454.

- a. Calculate the annual incidence rate of lung cancer in the US in 2004.

Incidence rate =  $173,770/292,287,454 = 5.95 \times 10^{-4} = 5.95$  in 10,000

- b. Calculate the mortality rate of lung cancer in the US in 2004.

Mortality rate =  $160,440/292,287,454 = 5.49 \times 10^{-4} = 5.49$  in 10,000

- c. Why is the mortality rate of lung cancer so high?

It is most often diagnosed in a very advanced (metastatic) state. Although early lung cancer is treatable, there are no good treatments for advanced lung cancer.

4. You have developed a new technology that could detect pre-cancerous cells in the sputum. This technology can enable much earlier detection of lung cancer, reducing the fraction of lung cancer patients that die of their disease from 92% to 15%. Your test costs \$100 to perform. Assume that on average, 18 years of life are lost when a person dies of lung cancer. There are 292 million Americans, 140 million of whom are over age 40. There are 173,770 new cases of lung cancer in the United States each year.

a. How much money would we spend annually if all adults over age 40 were screened with this new test?

$$(140,000,000) \times (\$100) = \$14,000,000,000 = \$14 \text{ billion}$$

b. Calculate the mortality rate of lung cancer without the use of the new test. Compare this to the expected mortality rate of lung cancer with the use of the new test.

$$\text{Without: } 173,770(.92)/292,000,000 = 5.47 \times 10^{-4} = 5.47 \text{ in } 10,000$$

$$\text{With: } 173,770(.15)/292,000,000 = 8.92 \times 10^{-5} = 8.92 \text{ in } 100,000$$

c. If the new test was used, how many years of life would be gained?

$$\text{Without: } 173,770(.92) = 159,868 \text{ will die losing } 159,868(18) = 2,877,624 \text{ years of life}$$

$$\text{With: } 173,770(.15) = 26,066 \text{ will die losing } 26,066(18) = 469,188 \text{ years of life}$$

$$\text{Years of life saved} = 2,877,624 - 469,188 = 2,408,436 \text{ years}$$

d. If this test was administered annually to all adults over age 40, how many \$ would we spend per year of life gained?

$$\$/\text{year of live saved} = \$14 \text{ billion}/2,408,436 \text{ years} = \$5,813/\text{year of life saved}$$

e. Based on your answer to part d and our discussions in class, do you think this test would be adopted in the developed world? In the developing world? Explain your reasoning.

Definitely yes in the developed world because it is less than \$100,000 per year of life saved.

Probably no in the developing world because total health expenditures per person are typically less than \$100.

5. For ages 15-44 what are the 3 leading causes of death:

a) in the developing world:

1. HIV/AIDS
2. Road accidents
3. Interpersonal violence

b) in the developed world:

1. Road accidents
2. Self inflicted injuries
3. Interpersonal violence

6. For ages 45-60 what are the 3 leading causes of death:

a. in the developing world:

1. Heart disease (ARF)
2. Cerebrovascular disease
3. Tuberculosis

b. in the developed world:

1. Heart disease (IHD)
2. Respiratory cancers
3. Cerebrovascular disease

7. How do air bags work to save lives? How did our demonstration with the egg illustrate this?

Air bags extend the time that a passenger comes to a stop during an accident, allowing them to experience fewer g's. The egg thrown against the wall decelerated rapidly and broke. The egg thrown against the sheet decelerated more slowly and did not break upon initial impact.

8. In the developing and the developed world, heart disease is the leading cause of mortality for persons aged 45-60. Describe the differences in the type of heart disease, its cause and treatments in these two settings.

a. Type of heart disease

Developing: Acute rheumatic fever    Developed: Ischemic heart disease

b. Cause

Developing: Initial infection with strep causes immune reaction against heart. Future infections with strep greatly enhance this reaction

Developed: Build up of plaque in coronary arteries leads to heart attack

c. Treatments

Developing: treat strep infections with penicillin, after first attack of ARF, take penicillin forever.

Developed: PTCA, CABG, medical management to dilate arteries

9. The following information is from a World Health Organization report on the reconstruction of health services in Bam, Iran, after the December 2003 earthquake.

“On Friday 26<sup>th</sup> of December 2003 at 5:27 a.m. an earthquake with the magnitude of 6.7 on the Richter scale hit the city of Bam. To date more than 31,000 people have been buried, 22,000 are injured, 7,400 seriously injured. In total, the earthquake has destroyed approximately 20,000 homes ... Damages to the health facilities are almost total ... According to the Ministry of Health’s information 50% of the health personnel are dead.” The “danger of outbreak of endemic diseases such as cholera, typhoid fever, malaria and leishmaniasis” is listed as a critical current priority.

The report states that before the earthquake, the total population of Bam District was 240,000. The point prevalence of cholera was 3 in 100,000 population. The point prevalence of malaria was 109.1 in 100,000 population.

- (a) Calculate the approximate number of cases of cholera and malaria in Bam District before the earthquake.

$$(240,000)(3/100,000) = 7.2 \text{ Cholera}$$

$$(240,000)(109.1/100,000) = 261.8 \text{ malaria}$$

- (b) Suppose a survey after the earthquake finds 43 cases of cholera in Bam District. How many times greater is the point prevalence of cholera compared to pre-earthquake levels? Include the change in population in your calculation.

$$43/209,000 = 2.06 \times 10^{-4} \text{ After}$$

$$3/100,000 = 3 \times 10^{-5} \text{ Before}$$

$$2.06 \times 10^{-4} / 3.0 \times 10^{-5} = 6.86 \text{ times greater afterwards}$$

- c) In a post-earthquake survey, how many cases of malaria in Bam District would it take to represent a ten-fold increase in the point prevalence of malaria compared to pre-earthquake levels? Include the change in population in your calculation.

$$\text{Old prevalence} = 109.1/100,000 = 1.091 \times 10^{-3}$$

$$\text{New prevalence} = (1.091 \times 10^{-3}) \times 10 = 1.091 \times 10^{-2}$$

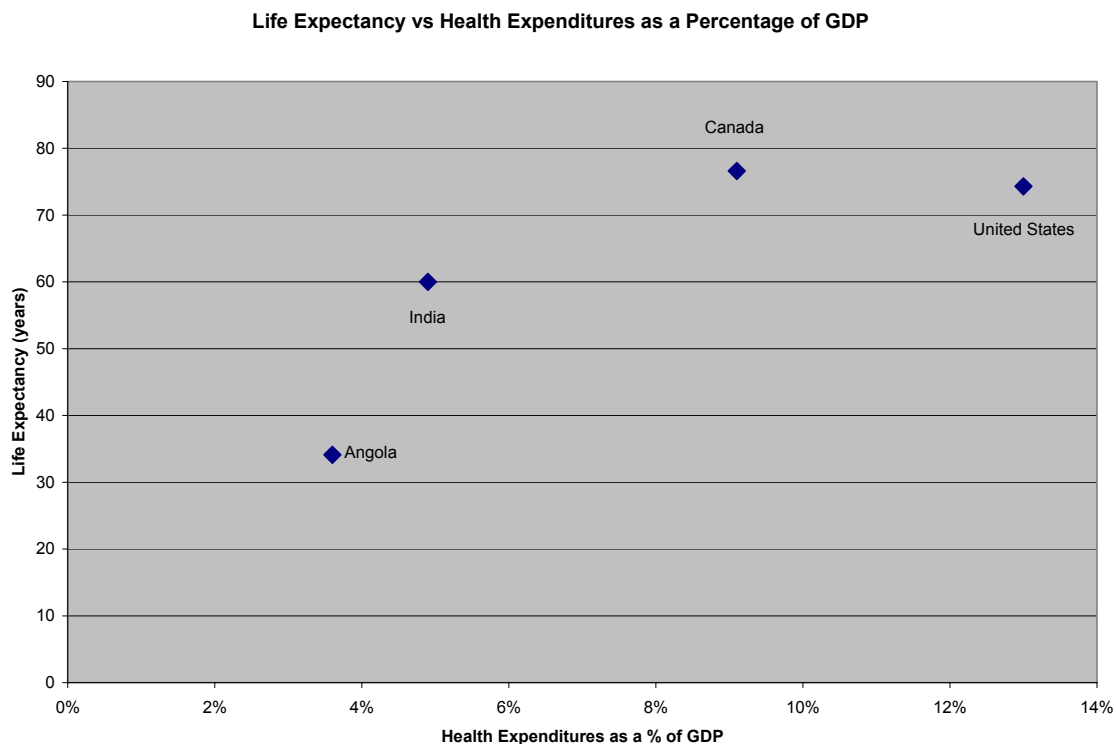
Prevalence = # cases/population

$$\begin{aligned} \# \text{ cases} &= (\text{prevalence})(\text{population}) \\ &= (1.091 \times 10^{-2})(209,000) \\ &= 2,280 \text{ cases} \end{aligned}$$

10. Use the data in the chart to answer the following questions.

Country	GDP per capita	Life expectancy at birth for males	Total health expenditures per capita	Total health expenditures as % of GDP
United States	\$34,637	74.3	\$4,499	13%
Canada	\$27,956	76.6 years	\$2,534	9.1%
India	\$1461	60 years	\$71	4.9%
Angola	\$1457	34.1 years	\$52	3.6%

- a) Make a graph that shows the life expectancy at birth for males vs. the total health expenditures as a percentage of the GDP for these four countries. Include a title and axis labels.



- b) List three reasons that life expectancy is lower in Angola than in Canada and the US.

1. 27 year long civil war in Angola
2. Per capita income is much lower and health spending is much lower in Angola
3. Incidence of HIV/AIDS is much higher in Angola

- c) HAART is a highly effective treatment for HIV infection. Do you think that a poor citizen living in each of these four countries would have access to HAART? Why or why not?

US – probably no if uninsured; probably yes if has Medicaid

Canada – Yes

India – probably no since reliance on private spending for health care is very high

Angola – probably no since health care resources are so very limited



EXTRA CREDIT:

1. Is the fish tank in Dr. Richards-Kortum's office a fresh or salt-water tank?

Salt water

2. What are our TAs' names?

Mark Carlson and Dina Pugach

3. What was one of the books that Dr. Richards-Kortum recommended in week 1 Notes from Home?

I Capture the Castle  
Possession