Biostatistics and Epidemiology Step 1 Sample Questions Set 2

Diagnostic and Screening Tests

1. A rare disorder of amino acid metabolism causes severe mental retardation if left untreated. If the disease is detected soon after birth a restrictive diet prevents mental abnormalities. Which of the following characteristics would be most desirable in a screening test for this disease?
   a. High sensitivity
   b. High specificity
   c. High positive predictive value
   d. High cutoff value
   e. High accuracy

2. A town with 1000 citizens has a 10% prevalence of disease X. A screening test for disease X just came out, with a sensitivity of 80% and a specificity of 70%. How many people with disease X will be missed by this screening test?
   a. 20
   b. 80
   c. 100
   d. 270
   e. 630

3. A standard test based on a serum marker is used to diagnose disease X. The distribution of the marker for this standard test in healthy and diseased patients is shown by the red curves in the graph below. A competitive company developed a new test based on the same marker. The distribution of the marker for the new test in healthy and diseased patients is shown by the black curves in the graph below. Compared to the old test, the new test has

   a. Higher sensitivity and lower specificity
   b. Higher sensitivity and higher specificity
   c. Higher sensitivity and the same specificity
   d. Lower sensitivity and higher specificity
   e. Lower sensitivity and lower specificity

   Serum marker level
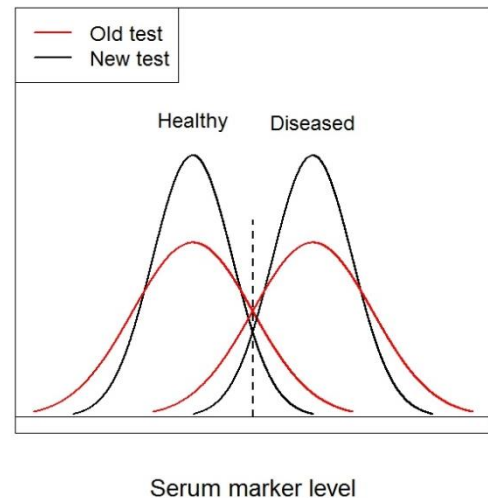
4. In a diabetes detection program, the cut-off level of blood sugar for Test A is set at 130 mg/100 mL and for Test B at 160 mg/100 mL. This means
   a. The sensitivity of Test B is greater than that of Test A.
   b. The specificity of Test B is greater than that of Test A.
   c. The sensitivity and specificity are the same for both tests.
   d. The number of false positives is greater with Test B than with Test A.

5. A new diagnostic test for tuberculosis has a sensitivity of 90% and a specificity of 95%. If applied to a population of 100,000 patients in which the prevalence of tuberculosis is 1%, how many false negative results would you expect?
   a. 10
   b. 50
   c. 100
   d. 500
   e. 900

6. A rapid test that is used to diagnose HSV infection is positive in HSV-infected patients 9 times more often than in non-infected patients. Which of the following expressions is used to derive this information?
   a. True positives/All positives
   b. True positives/True negatives
   c. Sensitivity/Specificity
   d. Sensitivity/(1 – Specificity)
   e. Specificity/(1 – Specificity)

7. A 52-year-old Caucasian female presents to your office with a self-palpated thyroid nodule. After the appropriate work-up, fine-needle aspiration (FNA) of the nodule is performed. The FNA result is negative. As you are explaining the test result, the patient asks, "What are the chances that I really do not have cancer?" You reply that the probability of thyroid cancer is low in her case because FNA has a high
   a. Specificity
   b. Sensitivity
   c. Positive predictive value
   d. Negative predictive value
   e. Validity

8. 190 patients with exercise-induced chest pain and a normal baseline ECG undergo stress ECG followed by coronary angiography. Coronary angiography is interpreted as positive if at least one coronary artery has an atherosclerotic lesion with ≥70% luminal stenosis. The following results are obtained.

		Coronary angiography	
		Positive	Negative
ECG Stress Test	Positive	90	10
	Negative	12	78

According to these study results, if a patient with exercise-induced chest pain has a negative ECG stress test, what is his/her probability of having a positive result on coronary angiography?
   a. 10/100
   b. 10/88
   c. 12/78
   d. 12/102
   e. 12/90

9. A new screening test for prostate cancer tends to diagnose non-aggressive forms of the disease but often misses more aggressive forms. An apparent increase in survival after implementation of the test would be most likely affected by
   a. Confounding
   b. Length-time bias
   c. Selection bias
   d. Ascertainment bias
   e. Measurement bias

Hypothesis Testing

10. In a placebo-controlled trial of the use of aspirin and dipyridamole to prevent arterial restenosis after coronary angioplasty, 38% of patients receiving placebo had restenosis, and 39% of patients receiving dipyridamole had restenosis. In reporting this finding, the authors stated that P > 0.05. This means
    a. The chances are greater than 1 in 20 that a difference would be found again if the study were repeated.
    b. The probability is less than 1 in 20 that a difference this large could occur by chance alone.
    c. The probability is greater than 1 in 20 that a difference this large could occur by chance alone.
    d. The chance is 95% that the study is correct.

11. High plasma C-reactive protein (CRP) level is believed to be associated with increased risk of acute coronary syndromes. A group of investigators is planning a study that would evaluate that association. Which of the following is the best statement of the null hypothesis for the study?
    a. High plasma CRP level carries increased risk of acute coronary syndromes
    b. High plasma CRP level is related to the occurrence of acute coronary syndromes
    c. High plasma CRP level has no association with acute coronary syndrome
    d. Acute coronary syndrome can be predicted by high plasma CRP
    e. High plasma CRP level can cause acute coronary syndromes

12. A large prospective study is designed to assess the association between postmenopausal hormone replacement therapy (HRT) and the risk of dementia, Alzheimer type. Small studies conducted earlier suggest a possible protective effect of HRT. What is the probability that the study will show an association if in fact HRT does affect the risk of dementia?
    a. α
    b. Type I error
    c. β
    d. Type II error
    e. $1 - \alpha$
    f. $1 - \beta$

13. A group of researchers mistakenly concludes from a poorly designed experiment that acetaminophen cures the common cold. These researchers have committed which of the following types of error?
    a. $1 - \beta$
    b. α
    c. β
    d. Type I error
    e. Type II error

14. A pharmaceutical researcher is examining the ulcerogenic potential of a new nonsteroidal anti-inflammatory drug. He gives 20 rats a single subcutaneous injection of the drug every day for 1 week, and gives a similarly matched group of 20 animals daily saline injections for 1 week. Twenty-four hours after the final injection, the investigator sacrifices the rats, removes their stomachs, and examines them to determine whether any ulcers were produced. He obtains the following data:

	Ulcers present	Ulcers absent
Drug	12	8
No drug	8	12

Which of the following tests would be most appropriate for determining whether administration of the drug increased the incidence of stomach ulcers?
    a. Analysis of variance (ANOVA)
    b. Chi-square (χ^2) test
    c. Linear regression
    d. Paired t-test
    e. Pearson correlation coefficient

15. A prospective study looked at obesity, diet, and exercise habits of individuals. Match the appropriate analytic method for each of the following hypotheses.
        A. t-test for comparing two populations
        B. Analysis of variance (ANOVA)
        C. Correlation analysis
        D. Chi-square test

    a. _____ Average age does not vary across four groups of fat consumption.
    b. _____ Multivitamin use does not differ between low fat and high fat consumption groups.
    c. _____ Average BMI is the same for the low fat and high fat consumption groups.

16. It is claimed that a new drug induces rapid and sustained weight loss by affecting triglyceride metabolism in the small intestine. The body mass index of 100 patients is calculated at baseline and compared to the value after 1 year of treatment with the drug. Which of the following tests is most likely to be employed by the investigators to analyze the study results?
    a. Paired t-test
    b. Two-sample t-test
    c. Fisher's exact test
    d. Chi-square test
    e. Analysis of variance

Confidence Intervals

17. A ten-year prospective study is conducted to assess the effect of regular supplementary folic acid consumption on the risk of developing Alzheimer's dementia. The investigators report a relative risk of 0.77 (95% CI = 0.59 to 0.98) in those who consume folic acid supplements compared to those who do not. Which of the following p-values most likely corresponds to the results reported by the investigators?
    a. 0.03
    b. 0.05
    c. 0.07
    d. 0.09
    e. 0.15

18. Two studies are conducted to assess the risk of developing asymptomatic liver mass in women taking oral contraceptive pills (OCP). Study A reports a relative risk of 1.6 (95% CI = 1.1 to 2.8) in women taking OCP compared to women not taking OCP over a five-year follow-up period. Study B reports a relative risk of 1.5 (95% CI = 0.8 to 3.5) in women taking OCP compared to women not taking OCP over a five-year follow-up period. Which of the following statements about the two studies is most accurate?
    a. Study A overestimates the risk
    b. The result in study B proves no causality
    c. The result in study A is not accurate
    d. The sample size in study B is small
    e. The p-value in study B is less than 0.05

19. To assess the efficacy of a new bronchodilator drug X, the peak expiratory flow rate of a population of asthmatics is measured during an asthma attack under three conditions: after no intervention, after the administration of albuterol, or after the administration of drug X. The graph shows the mean peak flow and 95% CIs for each condition. Which is the best statement regarding the results of the study?

    a. There is likely a significant difference between the mean peak expiratory flow rate of albuterol versus drug X
    b. There is likely a significant difference between the mean peak expiratory flow rate of albuterol versus no intervention
    c. There is likely a significant difference between the mean peak expiratory flow rate of drug X versus no intervention
    d. There is not likely a significant difference between the mean peak expiratory flow rate of albuterol versus drug X because the ratio of these two means is close to 1
    e. There is not likely a significant difference between the means of any of the conditions because the confidence intervals are too wide
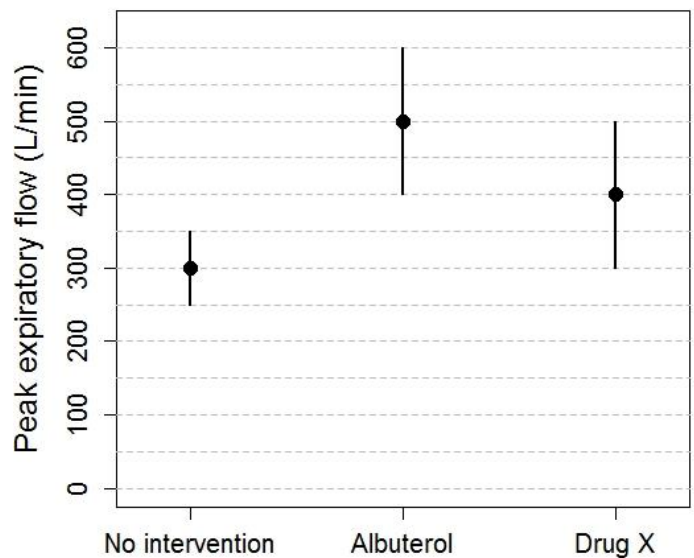
20. Part of the Third National Health and Nutrition Examination Survey was conducted in the United States in the 1990s to examine the relationship between obesity and depression. The authors investigated the association between major depression and body mass index (BMI) for males and females (*American Journal of Epidemiology*. 2003;158:1139-1147). Based on the table below, which of the following statements is true?

BMI Category, kg/m^2	Odds Ratio	95% Confidence Interval
Normal weight (BMI 18.5 – 24.9)	1.00	--
Underweight (BMI < 18.5)	1.17	0.49 – 2.80
Overweight (BMI 25.0 – 29.9)	0.86	0.53 – 1.41
Obese (BMI ≥ 30)	1.88	1.02 – 3.46
Class 1 (BMI 30 – 34.9)	1.28	0.64 – 2.56
Class 2 (BMI 35 – 39.9)	1.76	0.78 – 3.95
Class 3 (BMI ≥ 40)	4.98	2.07 – 11.99

    a. The odds of depression is significantly increased in individuals with BMI exceeding 40 as compared to individuals in all other BMI categories.
    b. The odds of depression in individuals of normal weight is significantly lower as compared to individuals with BMI exceeding 40.
    c. The odds of depression significantly increases with increasing BMI among those who are classified as obese.
    d. The odds of depression is significantly higher in obese individuals relative to overweight individuals.

21. Researchers measure cholesterol levels in a sample of patients in New Zealand and Asia and find the following results:

Region	Sample size	Mean Cholesterol Level (mmol/L)	Standard Deviation (mmol/L)
New Zealand	100	5.4	1.2
Asia	150	4.9	1.3

They calculate the mean and 95% CI for the true difference in mean cholesterol levels between the two populations and find: Mean difference = 0.5 mmol/L and 95% CI = 0.18 to 0.82. The 95% CI for the true difference in mean cholesterol levels between the two populations suggests that

    a. There is no statistically significant difference in mean cholesterol levels between the two populations
    b. There is a statistically significant higher mean cholesterol level in the Asian population as compared to the New Zealand population
    c. There is a statistically significant higher mean cholesterol level in the New Zealand sample as compared to the Asian sample
    d. There is a statistically significant higher mean cholesterol level in the New Zealand population as compared to the Asian population

Time-to-event Data Analysis

22. A study of patients with pancreatic cancer assesses the efficacy of a new chemotherapy regimen. The table below presents survival information for patients treated with the new regimen:

Time, in months	No. patients at the beginning of the interval	No. patients who died during the interval	Percentage of patients who died during the interval
0 – 1	200	20	10
1 – 2	180	10	5.6
2 – 3	170	12	7
3 – 4	158	18	11
4 – 5	140	20	14

What is the probability that a patient on the new regimen is alive at 3 months?
   a. 0.93
   b. 0.89
   c. (0.9 + 0.94 + 0.93)/3
   d. 0.9 X 0.94 X 0.93
   e. 1 – (0.89 X 0.86)

23. A randomized controlled trial was conducted to determine whether the combination of isosorbide dinitrate and hydralazine together in African Americans with heart failure was superior to placebo with respect to overall survival (*N Engl J Med*. 2004;351[20]:2048-2057). Kaplan-Meier estimates of survival were constructed and a log-rank test was performed. The results are shown below. Based on this information, which of the following conclusions is correct?

   a. The overall risk of death is significantly lower in the treatment group versus placebo comparing all time points between day 0 and day 600.
   b. The overall risk of death is significantly lower in the treatment group versus placebo at day 600.
   c. The overall risk of death is significantly higher in the treatment group versus placebo at day 600.
   d. The overall risk of death is approximately the same in both groups.
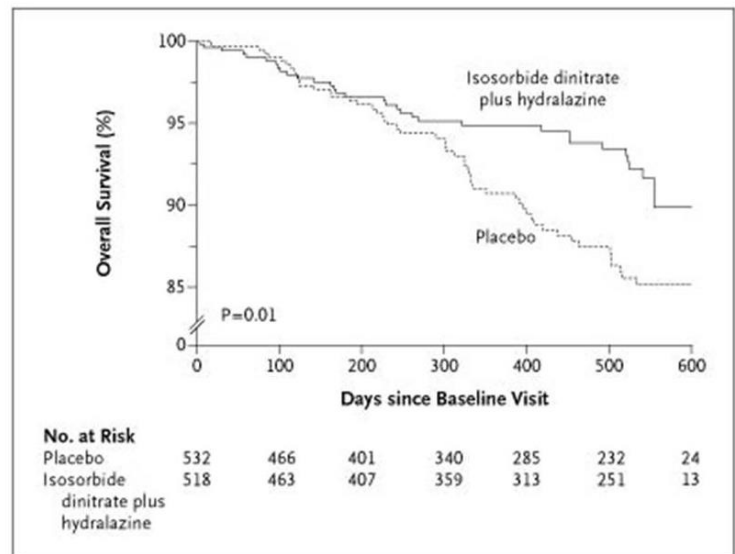
24. In this same study, the authors report a hazard ratio of 0.57 for the overall survival comparison. Which of the following conclusions is correct?
   a. The 95% CI for the HR includes 1
   b. The 95% CI for the HR excludes 1
   c. The 95% CI for the HR includes 0
   d. The 95% CI for the HR excludes 0