

BE.104 Spring '05
Quiz 1
(100pts total)

PLEASE, PUT YOUR NAME ON ALL PAGES WITH ANSWERS, INCLUDING ANY ADDITIONAL ATTACHED PAGES.

Question 1. 10pts

You are the public health official called to investigate a sudden increase in mild eye irritation complaints in individuals coming to the MIT Medical emergency room. You make arrangements to interview patients either in the emergency room or later by phone.

9pts (3pts each): What three specific categories of questions should you ask patients in order to formulate a plan to discover the cause of the increase in eye complaints?

Persons: Who is affected?
Places: Where were they when affected?
Time: When did their symptoms begin?

1pt: If you also interview patients in the ER who do not have an eye irritation complaint, what type of environmental health study have you initiated?

Retrospective, case-control

Question 2. 5pts

The eye irritation resolves rapidly in the emergency room after simple eye washing, but your investigation shows that the prevalence of eye irritation since the outbreak continues to increase.

What can you conclude about the incidence of eye irritation on MIT's campus?

It continues to increase, too.

Question 3. 15pts

You form the impression that contact lens wearers are over-represented among individuals who are affected by eye irritation.

5pts: What determination can you perform using only your interview data to quantify the effect of contact lens wear on the risk of developing eye irritation?

Relative risk analysis (Odds ratio is okay, too, if stated that total eye irritation incidence must be low.)

5pts: Design an ideal study that will allow you to determine the absolute population risk of eye irritation associated with wearing contact lens at MIT.

- 1. Prospective design**
- 2. Start with individuals who do not have eye irritation**
- 3. Randomly assign half to wear contacts and half to be contacts-free**
- 4. Wait to observe the incidence of eye irritation in the two groups**

5pts: What cause-effect determinant could your study address?

Necessary. Are contacts necessary for eye irritation?

Question 4. 5pts

Based on your analysis in #3, you establish that there is a statistically significant association between contact lens wear and eye irritation among your first interviewed population, with $p = 0.05$.

2pts: What is the probability that the observed association between contact lens wear and eye irritation occurred by chance?

0.05, 5%

1.5pts each: Name two improvements in your study that might reduce this probability?

Increase sample size

Decrease misclassification errors (i.e., a manifestation of variance)

(Can't effect delta in an observational analysis)

Question 5. 10pts

Because some individuals remove their contacts before coming to the emergency room and you wish to avoid reporting bias in classifying wearers and non-wearers, you develop a tear test that tells whether someone has been wearing contacts during the past 24 hours. The test is based on cellular cytokines that are induced by contact lens wear. Seventy-five percent of eyes with recently removed contacts have a test score ≥ 10 cytokine units, and 10% of totally contacts-free eyes have a test score ≥ 10 cytokine units.

What is the positive predictive value and negative predictive value of your test, if you call eyes with ≥ 10 cytokine units wearers and eyes with < 10 cytokine units non-wearers?

		Actual Contact Lens Status	
		<u>Worn</u>	<u>Not Worn</u>
Test result	Wearer	TP = 0.75	FP = 0.10
	Non-Wearer	FN = 0.25	TN = 0.90

PPV = TP/(TP+FP) x 100% = 88%

NPV = TN/(TN+FN) x 100% = 78%

Question 6. 10pts

You determine that the odds ratio for wearing contact lenses is 1.7.

3pts: What requirement must be met so that the odds ratio provides a good estimate of relative risk associated with contacts lens wear?

**The overall incidence of eye irritation in the evaluated population must be small.
Total affected <<<<< Total unaffected**

2pts: What quantitative error will you make if you use the odds ratio when this requirement is not met?

Overestimate relative risk of wearing contact lenses.

Question 6. Continued

3pts: Based on a Chi-square analysis, you determine that the 95% confidence interval for your odds ratio determination is 0.9 to 7.

What do you conclude about the observed effect of contact lens wear on the eye irritation? Explain your answer.

The value 1.0, which means no effect of contact lens wear on eye irritation incidence, is within the 95% confidence interval. Therefore, not significant at the 95% level of confidence (>5% likelihood that the observed odds ratio occurs by chance).

2pts: Given that your odds ratio is small, what analyses would help you in your assessment of how much of the increase incidence of eye irritation might be related to contact lens wear?

Attributable risk analysis.

Question 7. 10pts

One of your scientific staff members reports to you that the coefficient of variation of the distribution of tear cytokine measurements (from question #5) is 71% with a mean of 2 cytokine units.

Name three different possible explanations for this finding. I.e., what type of distribution could it be? **3pts each + 1pt if 3 correct answers are given**

3pts for any of these:

Poor measurement technique (normal distribution)

Skewed distribution

Bimodal distribution

Log normal distribution

Poisson distribution

Question 8. 20pts

Further investigation reveals the contact lens wear does not account for the incidence in eye irritation. Your investigation reveals that there may be an unknown agent released in the Infinite Corridor that is responsible for the increase incidence of eye irritation. To prepare for developing a study of Infinite Corridor exposure rates, you set up a walk-meter that determines the number of persons crossing the midway point of the corridor. You develop two distributions as described below.

Describe the character of these distributions. Explain your answers.

5pts: Distribution #1: number of individuals crossing during 5-minute intervals from 8 AM to 4 PM on an average academic-year day.

Normal. Lots of small random processes governing why people cross when they do, with high frequency of crossings.

5pts: Distribution #2: number of individuals crossing during 5-minute intervals from 2 AM to 5 AM on an average academic-year day.

Poisson. Low numbers of crossings that are random in occurrence, likely to be independent, and unlikely to significantly affect the population of potential crossers.

5pts: If you observe that the mean of distribution #2, described above, is 2, what is the likelihood that 5 people will cross the midway point of the Infinite Corridor during 5-minute intervals between 2 AM and 5 AM on an average academic-year day?

$$P = (e^{-2})(2^5)/5! = 0.036, 1 \text{ in } 28$$

5pts: If the mean of distribution #1, described above, is 100, what do you need to know to estimate how frequently more than 100 persons will cross the midpoint of the corridor during 5-minute intervals from 8 AM to 4 PM on an average academic-year day?

Nothing. Given a symmetric normal distribution, 50% of the time more than the mean number of persons will pass.

Question 9. 10pts

You develop methods for determining the degree of severity of eye irritation and the amount of time that affected individuals spend traveling in the Infinite Corridor.

2pts: How would you evaluate the degree to which eye irritation might depend on time in the corridor?

Determine R^2 , the coefficient of determination, using the Pearson product moment analysis

2pts: The dependency that you detect is not significant at the $p = 0.01$ level of confidence. What type of statistical error may you be making?

Type II, you think there is not a dependency, but there is.

2pts: Why might this error occur?

Low power.

4pts: Name four changes that can be made in the study design to reduce the chance of this error.

Increase sample size.

Reduce variance in measurements

Increase effect (“delta”) by focusing on individuals with longer times in the corridor

Reduce confidence requirement to $0.01 < p \leq 0.05$, to err on the side of safety for MIT students.

Question 10. 5pts

State Stigler’s law of misonomy.

“Nothing in mathematics is ever named after the person who discovered it.”