

AMS5 - Final
Tuesday 8th December, 2009

READ THE INSTRUCTIONS CAREFULLY

1. Write your answers in a Blue Book. Write, *in ink*, your name, your student ID number, your section day/time and your TA's name on the front of your blue book.
2. Write the exam code (at the top right of this page) on the front of your blue book.
3. This exam consists of four (4) regular questions, and two (2) bonus questions.
4. You should answer all the regular questions. Questions are not necessarily worth equal numbers of marks.
5. You are advised to read the questions carefully, and answer the question asked.
6. Begin your answer to each question on a new page.
7. You must show working or give explanations for all questions to get full marks.
8. A normal table and a χ^2 -table can be found at the end of this exam.
9. Hand in this question paper with your answers.
10. Three of the questions have bonus parts, and there are two bonus questions. You can get full marks without answering the bonus questions. Correct answers to the bonus questions will earn you additional marks, but you cannot score more than 100%.

1. (10 marks) A box of Chanukah candles contains 44 candles. In the last box that I bought, there were 19 white, 11 red, 5 blue and 9 yellow candles.
 - (a) Assuming that the boxes are filled by choosing candles randomly from a large batch of colored candles, what is a 95% confidence interval for the proportion of all candles that are blue?
 - (b) On the first night of Chanukah I select two candles at random from the box. What is the chance that I get
 - i. Two white candles?
 - ii. Two candles of the same color?
 - iii. Two different colored candles?
 - (c) My oldest son is sceptical that the factory that makes the candles makes equal numbers of each color. My younger son is (naturally) sceptical of his older brother's opinion. Which son does the distribution of colors in my box support?

2. (6 marks) Recently, Governor Schwarzenegger vetoed Assembly Bill 1176 with the following signing statement.

For some time now I have lamented the fact that major issues are overlooked while many unnecessary bills come to me for consideration. Water reform, prison reform, and health care are major issues my Administration has brought to the table, but the Legislature just kicks the can down the alley.

Yet another legislative year has come and gone without the major reforms Californians overwhelmingly deserve. In light of this, and after careful consideration, I believe it is unnecessary to sign this measure at this time.

Sincerely

Arnold Schwarzenegger

The astute reader will notice that, reading down, the first letter of each line spells out a less-than-subtle message. Arnie claims that this happened by chance.

- (a) Assuming that the initial letter of each word is equally likely to be any of the 26 letters of the alphabet, what is the chance of this seven-letter combination?
- (b) In English, however, letters do not occur equally often. The table below gives the frequency of occurrence of each letter used. How likely is the governor's seven-letter combination?

letter	c	f	k	o	u	y
frequency	2.782%	2.228%	0.772%	7.507%	2.758%	1.974%

- (c) However, some letters occur at the start of words more frequently than others. The next table gives the frequency of occurrence of each letter at the start of a word. How likely is the governor's seven-letter combination?

letter	c	f	k	o	u	y
frequency	3.511%	3.779%	0.690%	6.264%	1.487%	1.620%

The chances computed so far assume that the phrase was known in advance – that is, that the data is used to both suggest the hypothesis, and to compute its probability. Instead, we should calculate the chance that the seven letters form *any* meaningful phrase about the recipient.

- (d) How many possible seven-letter words are there?

A scrabble list contains 24029 seven-letter words.

- (e) What's the chance of a seven-letter word, with letters chosen uniformly at random, being one of these words?
- (f) Do you believe that this phrase appearing in the signing statement was “just a coincidence”?

3. (10 marks) Read the abstract of the journal article “Immobilisation versus immediate mobilisation after intrauterine insemination: randomised controlled trial” printed at the back of this exam.
- (a) Was this an observational study or a controlled experiment? Explain briefly. (Don’t just quote the study’s title.)
 - (b) Was it performed “blind”? “double blind”? Do you think that this is an important consideration in this type of study? Explain briefly.
 - (c) The study was performed at 7 different hospitals. Would variations in the treatment protocol (other than mobilization vs. immobilization) at the different hospitals affect the study? Explain why/why not.
 - (d) What is the hypothesis that the researchers are studying?
 - (e) Formulate their hypothesis in terms of a null hypothesis and an alternative hypothesis.
 - (f) At what significance level can you conclude that lying down helps women become pregnant?
 - (g) Explain why the test you performed in part (f) is valid.

4. (12 marks) For each of the years 1963-1996, the table gives the average quality rating for wine from Napa and Sonoma Valleys, and the number of frosts in each year¹.

1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
71.0	93.1	88.7	78.0	85.1	85.1	78.8	91.0	77.5	72.5	88.0	92.4
22	19	3	21	7	13	13	7	10	20	12	7
1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
87.7	84.0	82.6	87.7	79.9	89.1	86.5	87.2	88.1	93.6	91.1	89.3
9	16	6	0	10	3	0	12	4	0	11	0
1987	1988	1989	1990	1991	1992	1993	1994	1995	1996		
87.7	86.6	81.2	80.1	89.2	91.6	88.7	91.0	92.0	88.0		
4	2	14	11	8	6	5	1	0	2		

Mean quality is 86 and the SD of quality is 5.6

Mean number of frosts is 8.2 and the SD of the number of frosts is 6.4

The mean for year is 1997.5 and the SD for year is 9.96

- Is the correlation between quality and year negative or positive?
- The correlation coefficient between the number of frosts and the year is -0.57. Using the data in the table, what number of frosts would you predict for the year 2000? What is the RMS error for this prediction?
- Sketch the distribution of the predicted number of frosts in 2000 using the normal approximation. Is this likely to correspond to reality? Explain why/why not.
- Plot the scatter diagram for quality vs. the number of frosts.
- Identify on your plot a potential outlier. In which year did this occur?

The correlation coefficient between quality and the number of frosts is -0.64.

- Would the magnitude of the correlation coefficient increase or decrease if the outlier was ignored. Explain briefly.
- Why might you exclude this outlier?
- The quality values are averages for the region. Would the magnitude of the correlation coefficient increase or decrease if data were available for the vineyards individually? Explain briefly.
- Using the value for the prediction of the number of frosts in 2000 that you computed earlier, what is your prediction of wine quality for 2000?

¹The data is taken from “Asymmetric warming over coastal California and its impact on the premium wine industry”, R.R. Nemani et al., Climate Research, **19**:25-34, 2001.

Immobilisation versus immediate mobilisation after intrauterine insemination: randomised controlled trial

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ABSTRACT

Objective To evaluate the effectiveness of 15 minutes of immobilisation versus immediate mobilisation after intrauterine insemination.

Design Randomised controlled trial.

Setting One academic teaching hospital and six non-academic teaching hospitals.

Participants Women having intrauterine insemination for unexplained, cervical factor, or male subfertility.

Interventions 15 minutes of immobilisation or immediate mobilisation after insemination.

Main outcome measure Ongoing pregnancy per couple.

Results 391 couples were randomised; 199 couples were allocated to 15 minutes of immobilisation after intrauterine insemination, and 192 couples were allocated to immediate mobilisation (control). The ongoing pregnancy rate per couple was significantly higher in the immobilisation group than in the control group: 27% (n=54) versus 18% (34); relative risk 1.5, 95% confidence interval 1.1 to 2.2 (crude difference in ongoing pregnancy rates: 9.4%, 1.2% to 17%). Live birth rates were 27% (53) in the immobilisation group and 17% (32) in the control group: relative risk 1.6, 1.1 to 2.4 (crude difference for live birth rates: 10%, 1.8% to 18%). In the immobilisation group, the ongoing pregnancy rates in the first, second, and third treatment cycles were 10%, 10%, and 7%. The corresponding rates in the mobilisation group were 7%, 5%, and 5%.

Conclusion In treatment with intrauterine insemination, 15 minutes' immobilisation after insemination is an effective modification. Immobilisation for 15 minutes should be offered to all women treated with intrauterine insemination.

Trial registration Current Controlled Trials ISRCTN53294431.

INTRODUCTION

Intrauterine insemination with or without ovarian hyperstimulation is probably the most frequently applied fertility treatment in the world. One of the questions that has remained unresolved is whether pregnancy rates are positively influenced by immobilisation after insemination.

Several studies have investigated sperm migration and survival in the female genital tract. Spermatozoa may reach the fallopian tube—the site of fertilisation—within two to 10 minutes.¹⁻⁴ These data suggest that sperm migration to the site of fertilisation is independent of the position of the woman directly after intrauterine insemination.

In 2000, however, Saleh et al reported that if a woman remained in a supine position for 10 minutes after intrauterine insemination, the pregnancy rates increased significantly compared with immediate mobilisation (13% *v* 4% per cycle).⁵ Unfortunately, this randomised controlled trial was rather small and unbalanced, as 40 couples were compared with 55 couples. Also, the outcome of pregnancy was not defined. As the subject has not been studied since then, we assessed the effectiveness of immobilisation after intrauterine insemination in a large multicentre randomised clinical trial.

METHODS

Subfertile women between 18 and 43 years of age with an indication for treatment with intrauterine insemination were eligible for the trial. Couples using donor semen (fresh or cryopreserved) could also be included in the trial. We made no restrictions with regard to the use and type of controlled ovarian hyperstimulation during treatment cycles.

All couples had been investigated for infertility according to the guidelines of the Dutch Society of Obstetrics and Gynaecology.⁶ This included a medical history, cycle monitoring, semen analysis, postcoital test, and assessment of tubal patency. The woman's age, duration of subfertility, and whether subfertility was primary or secondary were documented. We defined duration of subfertility as the time from when the couple started actively trying to conceive to the time of start of treatment. If the couple had a previous pregnancy that had not resulted in a live birth, we defined duration of subfertility as the time from the first day of the pregnancy to the time of start of treatment. We defined primary subfertility as the absence of pregnancy in the current relationship.