MDCN 340 Practice Examination: November, 2003

PART A: Multiple Choice Examination
Select One Answer

1 The Pap smear is named for Dr. George Papanicolaou who developed this test in the 1930's. The Pap smear detects early stage cervical cancer prior to the onset of symptoms or cervical changes that can be detected by visual inspection alone. A woman with no history of cervical cancer who undergoes a Pap smear is best characterized by which of the following statements?

A. She is practicing primary prevention.
B. She is practicing secondary prevention.
C. She is practicing tertiary prevention.
D. She is practicing quaternary prevention.
E. None of the above.

2 A physician performs a randomized clinical trial that compares mortality rates associated with chemotherapy alone and radiation alone among 20 patients with lymphoma. Of the 10 patients allocated to chemotherapy, 1 died. Of the 10 patients allocated to radiation, 5 died. The relative risk of 0.2 was associated with a p-value of 0.09. Which interpretation of these results is most correct?

A. The study was underpowered to detect a difference at the 5% level of significance.
B. There was a statistically significant outcome.
C. There were too many subjects in this trial.
D. The study clearly proves that radiation therapy is superior to chemotherapy.
E. The absolute difference in mortality rates was 0.2.

3 A researcher assessed the relationship between radiation exposure and risk of leukemia by comparing the incidences of leukemia among two groups of mine workers (high and low radiation mines). It was found that the relative risk for developing leukemia was 2.0 among those workers exposed to the high radiation mine. The associated p-value was 0.03. Which statement best describes the meaning of the p-value in this study?

A. The probability that a relative risk of 2.0 or more is due to the play of chance alone is 3%.
B. There is a 3% difference in incidence rates of leukemia between the two groups of miners.
C. There were 3 cases of leukemia per 100 in each group of miners.

D. The power associated with this study was 3.0%.
E. The study did not meet statistical significance at the 5% level.

4 Which of the following statements about test characteristics is correct?

A. Sensitivity varies with the prevalence of disease in the population being tested.
B. A highly sensitive test is best for ruling in disease.
C. The positive predictive value varies with the prevalence of disease in the population being tested.
D. A highly specific test is best for ruling out disease.
E. The pre-test probability of disease is equal to the accuracy of the test.

5 Dr. XYZ studied the effect of 'second hand smoke' on the incidence of lung cancer using a cohort study design. No statistically significant difference in the rates of lung cancer were found between those exposed to second hand smoke when compared to those not exposed to second hand smoke. Over the next decade, it was proved that second hand smoke does cause lung cancer. Which of the following best describes the error made by Dr. XYZ.

A. He enrolled too many patients.
B. He was a smoker.
C. He followed patients for too long a period of time.
D. He committed a Type 1 error.
E. He committed a Type 2 error.

6 A randomized placebo controlled trial was carried out among subjects with elevated levels of LDL cholesterol. LDL cholesterol is a risk factor for myocardial infarction (MI). Among 1000 subjects allocated to active treatment there were 10 MIs. Among 1000 subjects allocated to placebo there were 40 MIs. What is the relative risk reduction of MI associated with active treatment under the conditions of this trial?

A. 0.01 (1%)
B. 0.04 (4%)
C. 0.75 (75%)
D. 1.00 (100%)
E. 2.00 (200%)

7 Prostate Specific Antigen (PSA) is used to screen for prostate cancer. A study was conducted to evaluate the PSA in a population of men. Among 100 men with proved prostate cancer there were 90 positive PSAs. Among 100 men in whom prostate cancer was ruled out there were 15 positive PSAs. For prostate cancer what is the likelihood ratio associated with a positive PSA?

A. 90
B. 75
C. 30
D. 15
E. 6

8 A physician-epidemiologist plots per capita red wine consumption (x-axis) against the incidence of myocardial infarction (y-axis) for several countries. It is noted that myocardial infarction is highest among the countries with the lowest per capita consumption of red wine. This type of research is an example of which of the following types of research?

A. Randomized controlled trial
B. Correlational study
C. Case series
D. Case control design
E. Retrospective cohort design

9 Which of the following comparisons between the case-control study design and the cohort study design is correct?

A. The case-control design is better for studying rare exposures than the cohort design.
B. The case-control design is more expensive than the cohort design.
C. The case-control design is better for studying rare diseases than the cohort design.
D. The case-control design is better for determining disease incidence than the cohort design.
E. The case-control design is less prone to recall bias than the cohort design.

10 An epidemiologist notes that there were 40 new cases of lung cancer diagnosed in a city of 100,000 people at risk for this disease between January 1, 1998 and December 31, 1999. What is the annual incidence of lung cancer for this population?

A. 2 per 100,000 per year
B. 2 per 10,000 per year
C. 40 per 100,000 per year
D. 8 per 100,000 per year
E. 400 per 100,000 per year

11 Which of the following attributes of cross sectional surveys is correct?

A. The cross sectional survey is the best study design for assessing the causes of diseases.

B. The cross sectional survey must be done in person.
C. The cross sectional survey can assess for a relationship (association) between variables.
D. The cross sectional survey is the best study design for determining disease incidence.
E. The cross sectional survey is the most expensive study design.

12 A statistics student encounters a dataset where diagnoses are coded with numbers. For example, pneumonia is coded with a '1', hypertension is coded with a '2', appendicitis is coded with a '3', and so on. Which of the following best describes the numerical component of this dataset?

A. Ordinal Scale
B. Ratio Scale.
C. Interval Scale
D. Nominal Scale
E. Ranked Data

13 Post-menopausal women are encouraged to supplement their diet with calcium tablets in order to prevent osteoporosis (thinning of the bones). Among women with no osteoporosis, calcium supplementation would be best characterized by which of the following?

A. Primary prevention.
B. Secondary prevention.
C. Tertiary prevention.
D. Screening.
E. Therapy.

14 Which of the following test characteristics are typical of a screening test?

A. High sensitivity and high specificity.
B. High sensitivity and low specificity.
C. Low sensitivity and high specificity.
D. Low sensitivity and low specificity.
E. Low sensitivity and low accuracy.

15 A cardiologist with an interest in preventative medicine wishes to know the proportion of seniors living in a nursing home who have hypertension. On December 10th, his research nurse reviews the medical records of all the seniors at the nursing home, interviews all the seniors, and measures their blood pressure. Each senior is then classified as having hypertension or not having hypertension on that day. What measure of disease frequency best describes the resulting proportion?

A. Cumulative incidence

B. Incidence density
C. Annual period prevalence
D. Case series
E. Point prevalence

16 Which of the following best describes the infant mortality rate (IMR) among differing levels of income in Canada?

A. The IMR is highest amongst families with the highest incomes.
B. The IMR does not vary with family income.
C. The IMR is lowest amongst families with highest incomes.
D. The relationship between IMR and income has not been studied.
E. There is no such measure of disease frequency called the infant mortality rate (IMR).

17 Consider a dataset that contains the birthweight of all Canadian children born during the last 50 years. Assuming that this dataset is normally distributed, which following statement is correct?

A. The mean, median, and mode share the same value.
B. The data is bimodal.
C. The median value is equal to the mode multiplied by 2.54.
D. 99% of the data points lay within 1 standard deviation of the mean value.
E. The dataset will contain negative numbers.

18 A randomized placebo controlled trial was carried out among subjects with mild hypertension. Among 1000 subjects allocated to active treatment there were 10 strokes. Among 1000 subjects allocated to placebo there were 20 strokes. What is the number needed to treat (NNT) to prevent a single stroke under the conditions of this trial?

A. 0.01
B. 10
C. 20
D. 30
E. 100

19 An epidemiologist is interested in the incidence of hepatitis A infection among a population of 1000 students who are known to be at risk for this disease. 500 students were followed for 1 year and among these students there were 40 cases of hepatitis A. Owing to a school zone change, the remaining 500 students could only be followed for 6 months and among these students there were 35 cases of hepatitis A. What is the incidence density of hepatitis A from this study?

A. 75 per 1000 per year

B. 10 per 100 per year
C. 75 per 500 per year
D. 1 per 100 per year
E. 10 per 1000 per year

20 A physician notices that 5 medical students from the same class have presented to the emergency department one afternoon with an unusual rash that developed after writing an examination. This rash has never been encountered before and the physician authors a paper describing these patients in a local medical journal. Which type of research best describes this physician's endeavors?

A. Interventional research
B. Randomized controlled trial
C. Case control research
D. Observational research
E. Economic analysis

ANSWERS:

1 B
2 A
3 A
4 C
5 E
6 C
7 E
8 B
9 C
10 B
11 C
12 D
13 A
14 B
15 E
16 C
17 A
18 E
19 B
20 D

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PART B: Multiple Choice Examination
Select the answers that apply

The following questions refer to the article, Accuracy of ED sonography in the diagnosis of acute appendicitis, Chen SC - *Am J Emerg Med* - 2000 Jul; 18(4): 449-52.

1. Which of the following are attributes of the study design used in this research?

    a) Observational research
    b) Interventional research
    c) Randomized controlled trial
    d) A double blind trial
    e) An open label design

2. What is the likelihood ratio associated with a positive ultrasound used to diagnose acute appenditicitis?

    A. 1.0
    B. 2.0
    C. 3.0
    D. 4.0
    E. 10.

3. Which of the following changes to the study design would improve (to any extent) the validity of this study?

    a) Random allocation of the subjects to receive either ultrasound or surgeon's clinical impression.
    b) Reducing the sample size.
    c) Having all subjects undergo a clinical examination AND ultrasound.
    d) Using different ultrasound techniques for different types of patients.
    e) Ensuring that a follow-up appointment was done for every patient enrolled into the trial.

4. What was the assessment of precision reported by the authors for the sensitivity of sonography (ultrasound)?

    A. The 95% confidence interval was 0.3 to 0.6.
    B. The standard deviation was plus / minus 10%.
    C. No assessment of precision was provided by the authors.
    D. The assessment of precision was 96.4%
    E. The confidence interval for sensitivity is equal to the accuracy of sonography.

5. Patients not taken for surgery were asked to return for a follow-up visit. However, not all patients returned for their follow-up visit. Which of the following statements regarding lack of follow-up for these patients is correct?

a) Lack of follow-up in this case had no effect on the validity of the study.
b) Patients not returning for follow-up were not included in the analysis.
c) Lack of follow-up may result in an underestimation of false negatives for appendicitis.
d) Lack of follow-up may impact on the likelihood ratios.
e) A sensitivity analysis can be used to address losses to follow-up.

Answer Key: 1 b, e. 2 C. 3 a,c,e. 4 C. 5 c,d,e

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DIAGNOSTICS

Accuracy of ED sonography in the diagnosis of acute appendicitis

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The objective was to compare the accuracy of abdominal sonography performed by emergency physicians in the diagnosis of acute appendicitis with that of the surgeons' clinical impression. Three hundred-seventeen patients with right lower abdominal pain admitted to the Department of Emergency Medicine at National Taiwan University Hospital in Taipei, Taiwan were prospectively included in this study. Patients were divided into two groups according to the time of day they visited the emergency department. Those patients visiting the emergency department during the day were included in group I and those during the night were in group II. Group I was diagnosed by sonography. Group II was diagnosed by surgeons' clinical impression without sonographic examination. The definitive diagnosis of acute appendicitis was confirmed by the pathological reports. In the diagnosis of acute appendicitis, group I had a sensitivity of 96.4%, a specificity of 67.6%, a positive predictive value of 89.8%, a negative predictive value of 86.2%, and an accuracy of 89.1%, and group II had a sensitivity of 86.2%, a specificity of 37.0%, a positive predictive value of 74.6%, a negative predictive value of 55.6%, and an accuracy of 70.6%. The overall accuracy of sonography performed by emergency

physicians in the diagnosis of acute appendicitis was superior to that of the surgeons' clinical impression.

Key Words:

Appendicitis

sonography

clinical impression

Acute appendicitis is one of the most common abdominal emergencies and is a challenging diagnosis in emergency practice. Although this disease entity has been recognized for more than 100 years, as of yet there has been no definitive test to diagnose an acute appendicitis. Many modalities have been used to aid the diagnosis of acute appendicitis, however, they are nonspecific and can not be used as a definitive test.[1] [2] [3] [4] [5] [6] [7] [8] Several reports showed that when sonography is used to aid in the diagnosis of different diseases there has been high sensitivity, specificity, and accuracy.[4] [7] [9] [10] [11] Therefore, all physicians should consider training in sonography to use it within their practice. Thus, sonography performed by physicians, including internists, surgeons, gynecologists, pediatricians, and urologists has become a new trend in clinical practice. Abdominal sonography was first performed in 1981 to show the inflamed appendix.[12] Some studies have shown the promising value of sonography in the diagnosis of acute appendicitis. [4] [9] [13] [14] [15] [16] [17] [18] Because radiologists are not always available in the emergency department, emergency sonography performed by emergency physicians is an inevitable clinical practice. To our knowledge, no study has compared the accuracy of sonography performed by emergency physicians with that of surgeons' clinical diagnosis.

In this study, we tried to determine whether abdominal sonography performed by emergency physicians in the diagnosis of acute appendicitis is superior to that of clinical impressions and as effective as that of radiologists.

MATERIALS AND METHODS

Between September 1997 and June 1999, 317 patients with right lower abdominal pain admitted to the Department of Emergency Medicine at the National Taiwan University Hospital (NTUH) in Taipei, Taiwan were prospectively enrolled on this study. When patients came to the Department of Emergency Medicine, they were first evaluated by one of the emergency physicians (emergency residency training in NTUH is a 5-year program). After taking a detailed history, performing a complete physical examination, and taking blood sample for complete blood count, a plain abdominal radiography examination was performed. Patients were divided into two groups according to the time of day they visited the emergency department.

Group I consisted of 147 patients admitted to the emergency department during the day shift (8 A.M. to 6 P.M.). If an acute appendicitis was diagnosed or suspected by emergency physicians, usually at the midresident level, they received further abdominal sonography examinations. Sonography was performed by staff members or senior emergency physicians, who had completed the fundamental gastrointestinal sonographic training course provided by The Society of Ultrasound in Medicine of the Republic of China (Table 1) . They also had more than 12 months of experience on sonographic examinations. At the point of the maximal tenderness area, sonography was performed with a handheld 3.75 MHz curved array transducer (Toshiba SSA-340A, Tochigi-Ken, Japan) using graded compression technique in both longitudinal and transverse image.[9] The sonographic criteria of acute appendicitis are a noncompressible appendix with an anteroposterior diameter that is consistently 7 mm or greater, an appendicolith, and an interruption in the continuity of the echogenic submucosa, or a localized periappendiceal fluid collection.[17] [18] Based on the

sonographic findings, the patient was placed into one of three categories: (1) appendicitis, including suppurative, gangrenous, perforated, or tumor formation; (2) other diseases; or (3) normal abdominal sonographic screening.

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Surgery was determined by the sonographic diagnosis. Patients with sonographic diagnosis of acute appendicitis were taken to surgery. Patients with other diseases diagnosed by sonography received appropriate treatment for their conditions. Patients with normal screenings were discharged from the hospital and were followed up at outpatient clinic within the following 2 weeks.

TABLE 1 -- TABLE 1. The Fundamental Gastrointestinal Sonographic Training Course

Basic physics and instrument in ultrasonography
Normal tomographic anatomy and examination technique in diagnostic abdominal ultrasound
Ultrasonography of the bowel great vessels, lymphoid system, mesentery, and abdominal well
Ultrasonography in diffuse parenchymal lesions of the liver, portal system, and spleen
Ultrasonography of the pancreas
Ultrasonography in focal lesions of the liver
Doppler ultrasound in digestive system
Ultrasonography of the gallbladder and biliary system
Ultrasonography of the general abdomen: surgical point of view
The impact of ultrasonography on other diagnostic modalities in abdominal diseases

Group II consisted of 170 patients admitted to the emergency department during the night shift (6 P.M. to 8 A.M.). They received initial clinical examinations by senior emergency physicians. If an acute appendicitis was diagnosed or suspected, the patients received a follow-up examination by a senior surgical resident. No additional diagnostic test was arranged. Surgery was determined by the surgeons' clinical impression. Patients with a surgeon's clinical diagnosis of acute appendicitis were taken to surgery. Complete blood cell count and clinical examinations were repeated 4 hours later in patients with suspected clinical appendicitis. Surgery was arranged if appendicitis was later diagnosed. Those patients without appendicitis were discharged and followed up at outpatient clinic within the following 2 weeks.

The results of the sonographic examination and the surgeon's clinical diagnosis were analyzed to determine sensitivity, specificity, positive and negative predictive values, and overall accuracy. The definitive diagnosis of appendicitis was confirmed by the pathological reports. The statistical difference between the two groups in this study was determined by the logistic regression with analysis of maximum-likelihood estimates method. A P value of $< .05$ was considered significant.

RESULTS

Three hundred-seventeen patients were included in this study. There were 82 male (55.8%) and 65 female patients (44.2%) in group I and the mean age was 37.1 years (ages ranged from 8 to 84 years) (Table 2) . Diagnostic results of graded compression sonography are shown in Table 3 . The number of patients with sonographic diagnosis of appendicitis, other diseases and normal screening were 118 patients (80.3%), 12 patients (8.2%), and 17 patients (11.5%), respectively. Of the 118 patients, 106 underwent surgery and were proven to have appendicitis by the pathological examinations. Of the other 12 patients who underwent surgery without appendicitis, 9 were found to have a normal appendix, and 3 had fecal impaction. Among the other 12 patients with other diseases, 5 had pelvic

inflammatory diseases, 3 had hydronephrosis, 2 had colitis, 1 had enteritis, and 1 had renal colic. One patient with colitis was proven to have appendicitis 3 days later. Three of 17 patients (17.6%) with normal sonographic screenings were found to have appendicitis during their second visit to the outpatient clinic.

TABLE 2 -- TABLE 2. The Demographic of 317 Patients With Right Lower Abdominal Pain

	Group I	**Group II**
No. of patients	147	170
Visit time	8 AM-6 PM	6 PM-8 AM
M/F	82/65	99/71
Age (mean)	8-84 (37.1)	5-85 (35.5)

TABLE 3 -- TABLE 3. Correlation of Sonographic Examination and Pathological Reports

		Final Diagnosis	
	Sonographic Examinations	**Appendicitis**	**Nonappendicitis**
Appendicitis	118	106	12
Other diseases	12	1	11
Normal screening	17	3	14
Total	147	110	37

Group II had 99 male (58.2%) and 71 female patients (41.8%) and with a mean age of 35.5 years (ages ranged from 5 to 85 years). Of the 134 patients who underwent surgery; 100 patients had appendicitis, 30 patients had no identifiable pathological process and 4 patients were found to have other pathological intraabdominal processes at surgery, including 2 pelvic inflammatory diseases, 1 ovarian cyst, and 1 mesenteric lymphadenitis. Sixteen patients who were diagnosed without appendicitis by a surgeon were found to have appendicitis within 1 week at outpatient clinics and emergency departments which was confirmed during laparotomy.

A total of 110 (74.8%) patients with pathological findings were diagnosed with appendicitis in group I and 116 (68.2%) patients in group II. Both groups had approximately the same incidences of appendicitis. The overall sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for sonographic examinations and surgeon's clinical impressions are displayed in Table 4 . A comparison of calculations showed that sonography was superior to the surgeon's clinical impression in the diagnosis of appendicitis ($P < .005$).

TABLE 4 -- TABLE 4. A Comparison of Sonographic Examinations and Surgeons' Clinical Impression

	Sonographic Examinations	**Surgeons' Clinical Impression**
Sensitivity	96.4%	86.2%
Specificity	67.6%	37.0%
Positive predictive value	89.8%	74.6%
Negative predictive	86.2%	55.6%

value		
Accuracy	89.1%	70.6%

DISCUSSION

Acute appendicitis is one of the most common abdominal emergencies requiring surgery. Over the past 100 years the mortality and morbidity rates related to this disease have been markedly reduced. A large measure of this progress has been the recognition of the serious effect of perforated appendicitis. Early surgical intervention has been recommended to prevent the perforation of the appendix; however,

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a high negative laparotomy rate was increased with aggressive surgical treatment. To prevent the delayed diagnosis, many modalities have been used to aid in the diagnosis of acute appendicitis.[1] [2] [3] [4] [7] Many studies have showed the promising value of sonography in the diagnosis of appendicitis. Although these results have been highly encouraging, no study has tested sonography performed by emergency physicians against the surgeons' clinical diagnosis.

Abdominal sonography examinations performed by staff radiologists have variable sensitivity, specificity, and accuracy in the diagnosis of acute appendicitis. These studies show a sensitivity of 36% to 99%, a specificity of 68% to 100%, and an accuracy of 64% to 96%.[5] [9] [11] [12] [13] [14] [15] [16] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] Our emergency sonography performed by emergency physicians showed a sensitivity of 96.4%, a specificity of 67.6%, an accuracy of 89.1%, a positive predictive value of 89.8% and a negative predictive value of 86.2%. Our results are comparatively better than most other studies of abdominal examinations performed by radiologists. This study shows the reliability for emergency physicians to perform sonographic examinations provided that emergency physicians received sonography training and underwent a period of sonography practice. It is possible that if surgeons receive sonographic training, they will also have as good results as those of emergency physicians. If sonography is performed by surgeons and the sonographic diagnosis of appendicitis compared with their clinical impression, the results will be more accurate.

Studies have shown that the accuracy of sonographic examination is operator-dependent and requires skill and experience.[20] [21] [25] For an independent sonographer to perform sonography and interpret the sonographic results with accuracy, adequate training is required. We consider 3 to 6 months of sonographic practice under a skilled sonographer's supervision and at least 50 cases experience of sonographic diagnosis of appendicitis as a minimal training for a sonographer to show an accurate diagnosis of appendicitis. Several studies reported that allowing the patients themselves to localize the point of maximal tenderness with the sonography transducer expedited the examination and helped identify the intraabdominal pathologies.[9] [16] There are two disadvantages of sonographic examinations.[31] [32] [33] First, the sonography beam can not penetrate gas and bone. Second, sonography is limited in obese patients. These drawbacks are likely to be amended with the advancement in electronic technology in the near future.

Three of 17 patients (17.6%) with normal sonographic screening were subsequently found to have appendicitis within the following 3 to 6 days. Wade et al[4] also reported that 24% of patients with normal screening were proven to have appendicitis. The reasons for these misdiagnoses may be attributed to early stages of appendicitis with minimal edematous change which failed to meet the diagnostic criteria, edematous appendix masked by bowel gases, inexperienced sonographers, or the working limitations of sonography. Repeated sonographic examinations of patients with normal screenings were suggested when their symptoms continued to persist after 4 to 6 hours of observation. One patient with appendicitis was misdiagnosed as colitis by sonography. The reactive thickness of colonic wall adjacent to the inflammatory appendix resulted in the sonographic misdiagnosis of colitis. More attention should be paid to

patients with sonographic diagnosis of colitis which is localized in the cecal area.

There are two drawbacks in this study. This is not a randomized study but patients comprised a convenience sample. Daily emergency visits in our department are approximately 250 patients. More than six emergency physicians staff work during the day shift and only one works during the night shift. It is difficult for the emergency physician staff to perform sonography at night. Therefore, only those patients who came to the emergency department during the day received sonographic examinations. Another drawback is lacking for follow-up on all patients not taken to surgery. Only those patients their symptoms recurrence came to outpatient clinics.

In conclusion, on the basis of our results, we have found that sonography performed by an emergency physician in the diagnosis of acute appendicitis is superior to that of a surgeon's clinical impression. We suggest that sonographic training should be included in the emergency residency and surgical residency training program. However, it is crucial to remember that sonography cannot be completely relied on and sonographic findings should be incorporated with other clinical information about the patient to prevent misdiagnoses.

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