Chapter 3

Diagnostic work–up: recommended routine clinical practices

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1. Clinical observation

Standardized clinical observation, including history taking, physical examination and routine laboratory analyses, is essential to ensure a common approach for the accurate diagnosis of acute lower abdominal pain. The evidence from this study shows that repeating clinical evaluation increased the accuracy of diagnosis. For a diagnostic performance study, the clinical diagnosis of pelvic inflammatory diseases presenting with acute lower abdominal pain in women at the time of admission yielded a specificity of only 50%; however, the specificity increased to 100% after 48 hours.[1]

Although clinical observation gives an acceptable level of accuracy for diagnosis since almost all emergency causes of acute lower abdominal pain will have clear-cut signs and symptoms during observation, clinical observation has some disadvantages. One disadvantage is it is time consuming and possibly results in a delay in carrying out surgery which may have unacceptable outcomes.[2] Another disadvantage of clinical observation is the reliability of clinical information. When different doctors evaluated the same patients, their medical reports often had crucial differences illustrating a lack of consistency.

Reliability of information between doctors in medical records can be measured in terms of Cohen's Kappa coefficient, that is:

$$\text{Kappa} = \frac{fo-fc}{N-fc}$$

While

f_o = the number of patients where two clinicians agree

f_c = the number of agreements that might be expected by chance

N = the number of patients

The Kappa = 0 means agreement by chance only, Kappa = 1 means totally agree, <0 means that agreement less than by chance.

In a study on reliability of medical records, Bjerregaardet. al demonstrated that physical signs in abdominal pain, evaluated by different doctors, were less reliable than history or diagnoses.[3] The Cohen's Kappa coefficients of inter-rater agreement from medical

records produced by different doctors were 0.31 for signs, 0.62 for previous history, and 0.56 for diagnoses.

Clinical diagnosis requires the recognition of specific characteristics to accurately identify each disease or condition. The term diagnostic indicator refers to clinical findings that are meaningful for diagnosis. Contrary to diagnostic tests, clinical diagnostic indicators are multivariable by nature; their diagnostic values are based on adding up to disease probability from the presence of such diagnostic indicators.[4]

A study carried out as part of this thesis identified clinical diagnostic indicators relating to acute lower abdominal pain in young adult women.[5] The study was conducted in Nakornping Hospital, a tertiary care hospital in the Northern region of Thailand. Medical records of 542 female patients, aged from 15 to 50 years, who were admitted to surgical or gynecological wards with a chief complaint of acute lower abdominal pain were used. Clinical indicators or clinical findings were analyzed and allocated into 3 diagnostic groups, appendicitis, obstetric & gynecological conditions (OB-GYNc), or non-specific abdominal pain (NSAP). All clinical diagnostic indicators were analyzed using polytomous logistic regression for their diagnostic values in terms of likelihood ratios of positivity. The results showed that anorexia, nausea/vomiting, shift of pain, presence of diarrhea, sites of tenderness, guarding or rebound tenderness, pregnancy, leukocytosis and neutrophil levels > 75 % in a complete blood count, were significant clinical indicators (Table 3.1). Results of pelvic examination were not included in the study variables because pelvic examinationwas not routinely performed in all cases unless gynecological conditions were suspected. Inclusion of pelvic examination information would result in missing data for appendicitis group and NSAP group.

Table 3.1 Likelihood ratio of positive clinical diagnostic indicators for the diagnosis of appendicitis, obstetric and gynecological conditions, and non-specific abdominal pain from multivariable polytomous logistic regression

Indicators	Appendicitis		Obstetric-gynecological conditions		Non-specific abdominal pain	
	LR+ (95%CI)	P	LR+ (95%CI)	p	LR+ (95%CI)	p
Age >25yr	1.07 (0.91-1.26)	0.395	1.09 (0.68-1.76)	0.711	0.71 (0.33-1.53)	0.379
Single	0.95 (0.80-1.12)	0.542	1.34 (0.84-2.14)	0.216	1.06 (0.49-2.30)	0.884
Duration of pain >24 hr	1.11 (0.94-1.31)	0.237	0.86 (0.51-1.44)	0.567	0.89 (0.50-1.57)	0.677
Shifting of pain	1.13 (0.99-1.28)	0.068	0.36 (0.13-0.99)	0.047	0.76 (0.35-1.68)	0.501
Anorexia	0.98 (0.81-1.17)	0.792	0.34 (0.13-0.88)	0.027	1.66 (0.69-4.00)	0.258
Nausea & vomiting	1.06 (0.93-1.19)	0.375	0.42 (0.23-0.76)	0.004	0.90 (0.50-1.63)	0.728
Abnormal vaginal bleeding	0.23 (0.03-1.51)	0.125	1.15 (0.56-2.39)	0.701	0.24 (0.03-2.30)	0.217
Diarrhea	0.84 (0.63-1.10)	0.207	0.85 (0.32-2.25)	0.738	2.93 (1.55-5.56)	0.001
Temperature ≥37.5° C	1.00 (0.88-1.14)	0.955	0.71 (0.38-1.33)	0.282	1.06 (0.54-2.06)	0.863
Tachycardia	0.95 (0.83-1.09)	0.441	1.05 (0.61-1.81)	0.852	1.22 (0.62-2.43)	0.565
Systolic BP ≤90 mmHg	0.88 (0.33-2.31)	0.792	2.08 (0.82-5.29)	0.124	0.78 (0.10-6.07)	0.816
RLQ tender	2.30 (1.17-4.51)	0.016	0.53 (0.31-0.93)	0.026	0.75 (0.31-1.82)	0.528
LLQ tender	0.22 (0.10-0.48)	<0.001	3.59 (2.27-5.66)	<0.001	0.79 (0.30-2.13)	0.647
Guarding/rebound tenderness	1.25 (1.10-1.43)	0.001	0.69 (0.42-1.12)	0.131	0.37 (0.19-0.71)	0.003
Hematocrit <33%	0.84 (0.65-1.09)	0.190	1.61 (0.87-2.98)	0.126	0.98 (0.43-2.23)	0.960
WBC ≥10000/mm^3	1.74 (1.38-2.20)	<0.001	0.38 (0.20-0.74)	0.004	0.36 (0.20-0.67)	0.001
Neutrophil ≥75%	1.00 (0.88-1.15)	0.956	1.96 (1.11-3.45)	0.021	0.33 (0.16-0.66)	0.002
Pregnancy	0.31 (0.14-0.69)	0.004	2.24 (1.18-4.25)	0.014	1.18 (0.32-4.29)	0.806

This shows the effect of clinical indicators on whether they may increase (LR+ > 1) or decrease (LR+ < 1) the likelihood of a diagnosis. We can summarize the significance of the diagnostic indicators and their effect on the likelihood of a diagnosis of appendicitis, an

obstetric and gynecological condition (OB-GYNc) or non-specific abdominal pain (NSAP) as shown in Table 3.2.

Table 3.2 Effects of diagnostic indicators on the likelihood of diagnosis of acute lower abdominal pain in women of reproductive age

Diagnostic indicators	Likelihood of diagnosis		
	Appendicitis	OB-GYNc	NSAP
Anorexia		Decrease	
Nausea/vomiting		Decrease	
Shifting of pain		Decrease	
Diarrhea			Increase
Right lower quadrant tenderness	Increase	Decrease	
Left lower quadrant tenderness	Decrease	Increase	
Guarding/rebound tenderness	Increase		Decrease
Pregnancy	Decrease	Increase	
WBC ≥10000/mm^2	Increase	Decrease	Decrease
Neutrophil ≥75%		Increase	Decrease

(Table 3.1 & 3.2 were adapted from Jearwattanakanok K, Yamada S, Suntornlimsiri W, Smuthtai W, Patumanond J. Clinical Indicators for Differential Diagnosis of Acute Lower Abdominal Pain in Women of Reproductive Age. *Journal of Current Surgery.* 2013;3(1):13-18.)

From the data summarized inTable 3.2, the study found that the presentation of right lower quadrant tenderness, guarding/rebound tenderness, leukocytosis and neutrophil levels >75%, increased the likelihood of the condition being appendicitis while presentation of left lower quadrant and pregnancy decreased the likelihood of appendicitis. In the case of OB-GYNc, left lower quadrant tenderness, pregnancy, and neutrophil levels >75% increased the likelihood while anorexia, nausea/vomiting, shift of pain, right lower quadrant tenderness and leukocytosis decreased the likelihood of OB-GYNc. Diarrhea was the only clinical indicator that increased the likelihood of NSAP. If a female patient presents with right lower quadrant tenderness and guarding/rebound tenderness and the complete blood count shows leukocytosis with neutrophils predominating, the most likely diagnosis of this patient is appendicitis. Likewise, a patient with left lower quadrant tenderness, pregnancy and neutrophils predominating is more compatible with an OB-GYNc diagnosis. For acute lower abdominal pain patients who present with diarrhea, NSAP should be considered.

1.1 Pelvic examination and digital rectal examination

Contrary to the conventional medical myth that women with acute lower abdominal pain should be examined via a pelvic examination, the information gained from the pelvic examination is not as useful as could be expected.[6] In 94% of patients who underwent a pelvic examination for abdominal pain or vaginal bleeding, the results did not give enough information to inform the clinical plans for management.[7]

Similarly, a digital rectal examination has little diagnostic value in the evaluation of pain in the right lower abdominal quadrant. When combined with another clinical examination technique (the test for rebound tenderness), per rectal examination yielded no additional diagnostic value.[8]

Although the diagnostic yield from a physical examination, especially from pelvic examination, is difficult to interpret for many emergency physicians, it has however, great value if performed by specialist gynecologists. Pelvic examination by specialist gynecologists has the advantage of giving more reliable results and if the information from a transvaginal ultrasound scan is added to the results there is an increase in diagnostic accuracy. However, female patients with acute lower abdominal pain are likely to have been evaluated by their family doctor or an emergency physician in the first instance so there needs to be training for these doctors in recognizing the need to refer patients to specialists if needs be . The need for the screening of patients who will benefit from gynecologist consultation are not well addressed. The studies from this thesis can identify these patients by diagnostic indicators and clinical diagnostic scores. [5, 9]

2. Ultrasound

With the advantages of high sensitivity, low cost, wide availability and lack of ionizing radiation, ultrasound is considered the best option for primary imaging investigation for acute lower abdominal pain in women, especially when gynecological conditions are suspected.[10]

The criteria from ultrasound findings which can be used in the diagnosis of appendicitis are: 1) visualization of a non-compressible non-peristaltic appendix; 2) target-

like appearance in transverse view and 3) a diameter greater than or equal to 7 mm. With these criteria, ultrasound yields sensitivity of 82.5% and a specificity of 98.0%.[11]

While it is possible to rule-out appendicitis if a normal appendix is identified, only 5% of normal appendixes can be demonstrated from ultrasound.[12] Therefore the value of a normal ultrasound scan in ruling-out appendicitis is limited.

3. Computerized tomography

For patients with suspected appendicitis, a spiral CT scan has a sensitivity of 90 to 100%, a specificity of 91 to 99%, a positive predictive value of 95 to 97 %, and an accuracy of 94 to 100 %.[12] When compared to ultrasonography, CT had a greater sensitivity (96 % vs. 76 %), greater accuracy (94 % vs. 83 %) and a higher negative predictive value (95 % vs. 76 %).[13] Helical CT is an excellent imaging technique for differentiating appendicitis from acute gynecological conditions. In one study CT had a sensitivity of 100 % and a specificity of 97 % in the diagnosis of appendicitis, and a sensitivity of 87 % and a specificity of 100 % in the diagnosis of acute gynecological conditions. The overall accuracies were 98 % and 98 % for the diagnosis of appendicitis and acute gynecological conditions, respectively.[14]

Computerized tomography is widely recommended for the diagnosis of patients with suspected appendicitis. Information gained from CT scans in patients with suspected appendicitis results in alternative diagnoses of between 6% and 36%.[15] It is also cost-effective to perform a CT scan for informing the diagnosis of women of reproductive age suffering with right lower quadrant pain.[16] CT has a particular issue in the screening of pregnant women due to radiation exposure and the need for contrast media; therefore, ultrasound is recommended as a first line imaging investigation for informing the diagnosis in pregnant women with acute lower abdominal pain[17].

The value of a routine order for a CT scan for a diagnosis of appendicitis is controversial. In one study, routine CT scans for the diagnosis of appendicitis showed no superiority to the accuracy of clinical judgment by surgeons.[18] The issue of cost-effectiveness is also dependent on the healthcare reimbursement scheme. A study in Taiwan, whose healthcare reimbursement is a global budgeting scheme similar to that of Thailand, the use of CT did not show as more cost-effective than conventional clinical evaluation and routine laboratory investigation.[19]

4. Laparoscopy

The high proportion of nonspecific diagnosis of acute lower abdominal pain[20] and high negative appendectomy rate in women of reproductive age[21] make it tempting to perform 'direct vision' or laparoscopy investigation in all these patients. A laparoscopy has two advantages; first, it provides direct vision of intra-abdominal organs; secondly, it is possible to perform definitive surgery via laparoscopy.

The diagnostic value of carrying out a laparoscopy in women with nonspecific lower abdominal pain had already been studied and evaluated. Data suggest that early laparoscopy, compared with active observation, gives better results in establishing a final diagnosis clarifying the initial diagnosis on admission.[22] However, there is too little evidence to support the need for a routine early laparoscopy to inform the diagnosis of acute lower abdominal pain in women.[1, 23, 24]

A routine laparoscopy to inform the diagnosis in women with acute lower abdominal pain has some disadvantages. It is more invasive and has more risk associated with the procedure when compared with an imaging investigation. Laparoscopy also needs a skilled practitioner to perform the procedure and is a surgical procedure, taking place under some level of anesthetic. These are serious limitations in the practice of the extensive use of using laparoscopy to inform the diagnosis of acute lower abdominal pain.

5. Rationale in applying diagnostic modality

There are some issues to be considered in selecting diagnostic modality for acute lower abdominal pain in women of reproductive age. Diagnostic procedures are based on the gathering of clinical data to rule-in and rule-out clinical conditions until a definite diagnosis is reached. Physicians have specific roles in forming a hypothesis of what the symptoms are of any disease that the patient may have and they need to test the hypothesis with clinical data from history taking, physical examination, and sometimes, with special investigative procedures. Issues to be considered for the selection of diagnostic procedures are: accuracy, timely action and benefits versus harm and cost. Accuracy in the diagnosis of a specific disease needs to be high since unnecessary operations and undetected serious conditions are not acceptable. However, more accurate diagnoses may need more time for re-evaluation if a clinical observation modality is chosen. The rationale of using specialist

investigative techniques is to reduce diagnostic waiting time and increase diagnostic accuracy. Special investigations such as: ultrasound, CT scans and laparoscopy, take time to perform, but they may have benefits in uncertain cases and result in the proper selection of treatment. In cases with clinical findings which strongly suggest a diagnosis, special investigations are likely to have little diagnostic value and result in increasing the time to surgery or treatment and also increase the cost. Moreover, risk of radiation exposure in a CT scan and the risk involved in the carrying out of a laparoscopy, have to be weighed against the beneficial gain of such procedures. Even specialist consultation can be viewed as a special investigation modality. Proper consultation is a key to timely accurate diagnosis. Therefore, we need a system to identify the need for patients to be directed towards diagnostic modality or consultation.

References

1. Gaitan H, Angel E, Diaz R, Parada A, Sanchez L, Vargas C**.** Accuracy of five different diagnostic techniques in mild-to-moderate pelvic inflammatory disease. Infect Dis Obstet Gynecol. 2002;10(4):171-80.

2. Adamu A, Maigatari M, Lawal K, Iliyasu M**.** Waiting time for emergency abdominal surgery in Zaria, Nigeria. Afr Health Sci. 2010;10(1):46-53.

3. Bjerregaard B, Brynitz S, Holst-Christensen J, Jess P, Kalaja E, Lund-Kristensen J, Thomsen C**.** The reliability of medical history and physical examination in patients with acute abdominal pain. Methods Inf Med. 1983;22(1):15-8.

4. Moons KG, van Es GA, Michel BC, Buller HR, Habbema JD, Grobbee DE**.** Redundancy of single diagnostic test evaluation. Epidemiology. 1999;10(3):276-81.

5. Jearwattanakanok K, Yamada S, Suntornlimsiri W, Smuthtai W, Patumanond J**.** Clinical Indicators for Differential Diagnosis of Acute Lower Abdominal Pain in Women of Reproductive Age. Journal of Current Surgery. 2013;3(1):13-8.

6. Brown T, Herbert ME**.** Medical myth: Bimanual pelvic examination is a reliable decision aid in the investigation of acute abdominal pain or vaginal bleeding. CJEM. 2003;5(2):120-2.

7. Brown J, Fleming R, Aristzabel J, Gishta R**.** Does pelvic exam in the emergency department add useful information? West J Emerg Med. 2011;12(2):208-12.

8. Dixon JM, Elton RA, Rainey JB, Macleod DA**.** Rectal examination in patients with pain in the right lower quadrant of the abdomen. BMJ. 1991;302(6773):386-8.

9. Jearwattanakanok K, Yamada S, Suntornlimsiri W, Smuthtai W, Patumanond J**.** Clinical Scoring for Diagnosis of Acute Lower Abdominal Pain in Female of Reproductive Age. Emergency Medicine International. 2013;2013:6.

10. Ackerman SJ, Irshad A, Anis M**.** Ultrasound for pelvic pain II: nongynecologic causes. Obstet Gynecol Clin North Am. 2011;38(1):69-83, viii.

11. Schwerk WB, Wichtrup B, Rothmund M, Ruschoff J**.** Ultrasonography in the diagnosis of acute appendicitis: a prospective study. Gastroenterology. 1989;97(3):630-9.

12. Paulson EK, Kalady MF, Pappas TN**.** Clinical practice. Suspected appendicitis. N Engl J Med. 2003;348(3):236-42.

13. Balthazar EJ, Birnbaum BA, Yee J, Megibow AJ, Roshkow J, Gray C**.** Acute appendicitis: CT and US correlation in 100 patients. Radiology. 1994;190:31-5.

14. Rao PM, Feltmate CM, Rhea JT, Schulick AH, Novelline RA**.** Helical computed tomography in differentiating appendicitis and acute gynecologic conditions. Obstet Gynecol. 1999;93(3):417-21.

15. Neumayer L, Kennedy A**.** Imaging in appendicitis: a review with special emphasis on the treatment of women. Obstet Gynecol. 2003;102(6):1404-9.

16. Morse BC, Roettger RH, Kalbaugh CA, Blackhurst DW, Hines WB, Jr.Abdominal CT scanning in reproductive-age women with right lower quadrant abdominal pain: does its use reduce negative appendectomy rates and healthcare costs? Am Surg. 2007;73(6):580-4; discussion 4.

17. Chen MM, Coakley FV, Kaimal A, Laros RK, Jr.Guidelines for computed tomography and magnetic resonance imaging use during pregnancy and lactation. Obstet Gynecol. 2008;112(2 Pt 1):333-40.

18. Morris KT, Kavanagh M, Hansen P, Whiteford MH, Deveney K, Standage B**.** The rational use of computed tomography scans in the diagnosis of appendicitis. Am J Surg. 2002;183(5):547-50.

19. Lin KH, Leung WS, Wang CP, Chen WK**.** Cost analysis of management in acute appendicitis with CT scanning under a hospital global budgeting scheme. Emerg Med J. 2008;25(3):149-52.

20. Kruszka PS, Kruszka SJ**.** Evaluation of acute pelvic pain in women. Am Fam Physician. 2010;82(2):141-7.

21. Wen SW, Naylor CD**.** Diagnostic accuracy and short-term surgical outcomes in cases of suspected acute appendicitis. CMAJ. 1995;152(10):1617-26.

22. Dominguez LC, Sanabria A, Vega V, Osorio C**.** Early laparoscopy for the evaluation of nonspecific abdominal pain: a critical appraisal of the evidence. Surg Endosc. 2011;25(1):10-8.

23. Morino M, Pellegrino L, Castagna E, Farinella E, Mao P**.** Acute nonspecific abdominal pain: A randomized, controlled trial comparing early laparoscopy versus clinical observation. Ann Surg. 2006;244(6):881-6; discussion 6-8.

24. Gaitan HG, Reveiz L, Farquhar C**.** Laparoscopy for the management of acute lower abdominal pain in women of childbearing age. Cochrane Database Syst Rev. 2011(1):CD007683.