Acute abdominal pain : considerations on diagnosis and management

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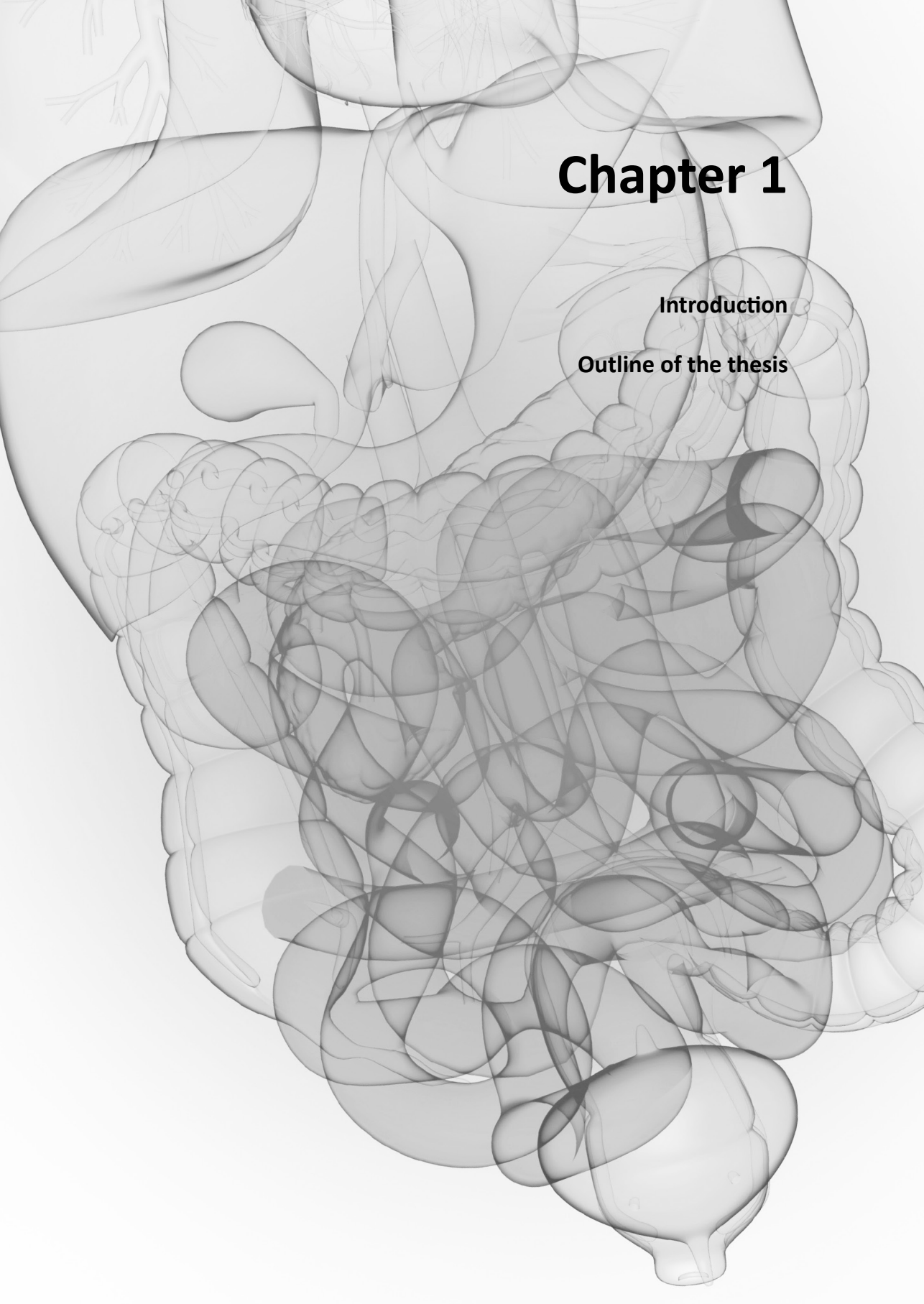

Chapter 1

Introduction

Outline of the thesis

Introduction

Approximately 5% of all patients evaluated at an emergency department present with acute abdominal pain[1]. Most of these patients will have self-limiting disease for which no surgical intervention is required such as non-specific abdominal pain (NSAP), constipation and gastroenteritis. The most frequent surgical emergencies are acute appendicitis, colonic diverticulitis and cholecystitis[2], and patients with these disorders can have very different presentations and severity of disease. It is important to identify those patients that require emergency surgery promptly. However, clinical decision making for patients with acute abdominal pain can pose a dilemma for the evaluating physician or surgeon; false positive diagnoses for perceived surgical emergencies will lead to unnecessary surgical explorations (type I error), whereas false negative diagnoses for surgical emergencies may result in treatment delay (type II error). Both these 'flawed' decisions will be accompanied by a risk of unnecessary morbidity. An accurate diagnosis is therefore of great importance. Solid clinical evaluation by patient history, physical examination and blood and urine analysis is the cornerstone of any emergency department assessment for acute abdominal pain. Clinical evaluation however, is not perfect. The overall accuracy for the clinical diagnosis acute appendicitis is approximately 80%, which corresponds to a mean false-negative appendectomy rate of 20%[3]. The clinical diagnosis acute colonic diverticulitis has a reported sensitivity and specificity of 64% and 97% respectively, leaving 36% of the patients with acute colonic diverticulitis to be missed by clinical evaluation[4]. Due to the fallibility of clinical evaluation for the diagnosis and management of patients with acute abdominal pain, many additional diagnostic modalities have been proposed in the literature. Clinical scoring systems, computer based analysis, radiological imaging (computed tomography, ultrasound, magnetic resonance imaging), and diagnostic laparoscopy have all been recommended to complement the clinical evaluation of a patient with acute abdominal pain at the emergency department.

Clinical scores such as the Alvarado score for appendicitis[5] and the pediatric appendicitis score described by Samuel[6] were said to aid the clinician to determine

appropriate management for patients with suspected appendicitis. However, when these scores were prospectively validated by others, the accuracies reported by the original authors could not be reproduced[7,8], and the scores could not determine the need for surgery accurately[9]. A recent study comparing 4 clinical scores for appendicitis confirmed this[10]. The authors found that the clinical scoring systems were inadequate at identifying patients with a high probability of appendicitis that should undergo direct appendectomy. Scoring systems may aid the clinical assessment, but cannot be used to accurately determine management.

Another diagnostic tool for patients with acute abdominal pain is computer aided diagnosis. Early reports in the 1980's claimed an improved diagnostic accuracy, reduced negative laparotomy rates, reduced rates of perforated appendicitis, better patient management, and cost effectiveness[11]. Unfortunately these impressive results were not reproducible and were attributed to the effects of structured data collection methods and audit feedback to clinicians[12,13]. It was concluded that computer aided diagnosis based on Bayes formula did not have a useful role in the diagnosis of acute abdominal pain, and today such programs are not frequently used. Recently however, a systematic review of ten studies on computer aided diagnosis for acute abdominal pain demonstrated an overall improvement in clinical diagnostic accuracy of 17.25%[14]. The authors concluded that computer aided decision support (CADS) still has a role in the initial evaluation of patients with acute abdominal pain, and that more work should be done to assess the inception of CADS in the emergency department for patients with acute abdominal pain.

Radiological imaging is the most established addition to the 'basic' clinical evaluation for patients with acute abdominal pain. Abdominal ultrasound can assist in the diagnosis of many gastrointestinal causes of acute abdominal pain[15], and its routine use by surgeons has been shown to increase diagnostic accuracy[16]. A recent meta-analysis showed ultrasound to have a sensitivity and specificity for acute appendicitis of 78% and 83% respectively[17]. For acute colonic diverticulitis ultrasound has a reported sensitivity and specificity of 77-98% and 80-99% respectively[18-22].

The advantage of ultrasound is that it does not require ionizing radiation or the application of oral, rectal or intravenous contrast, and thus it can be repeated as often as needed. Furthermore, the costs are lower and the spatial resolution of a high-frequency ultrasound image is higher than that of a CT image providing more detailed information on the different bowel wall layers when a graded compression technique is used[15,23]. A disadvantage of ultrasound is that it is operator dependent and that good imaging is difficult in patients with increased levels of body fat.

Computed tomography (CT) has also been reported to increase diagnostic accuracy, reduce hospital admissions[24], and is said to be the best predictor of the need for an urgent intervention[25]. Surgical and radiological literature consistently report CT to have a higher accuracy than ultrasound for urgent surgical diagnoses. The sensitivity and specificity for acute appendicitis in a meta-analysis was 91% and 90% respectively[17]. For acute colonic diverticulitis CT has been reported to have a high sensitivity (93-97%) and specificity approaching 100%[26,27]. A disadvantage of CT is that it exposes patients to ionizing radiation. This is an important issue as the rapidly growing use of CT is steadily increasing the collective dose of medical radiation to which patient populations are subjected. Even though the cancer risk from an abdominal CT is small for the individual, the increasing use of CT may create a future health concern, especially for children[28]. The indications for ordering a CT should therefore always be carefully scrutinized by medical personnel, especially when other diagnostic modalities can attain similar results[29].

Magnetic resonance imaging (MRI) may be an attractive alternative to CT as it does not use ionizing radiation, has a high contrast resolution, and techniques that shorten the examination time are currently available[30]. MRI has been shown to have an excellent diagnostic accuracy for acute appendicitis[31], and may be helpful for the diagnosis of acute appendicitis in pregnant patients with equivocal ultrasound examinations[32].

Laparoscopy can also accurately distinguish patients that require surgery from those that can be treated conservatively[33] and has been proposed as routine management for patients with acute abdominal pain in whom the decision to operate is uncertain[34].

However, we consider diagnostic laparoscopy in itself to be an operation, and believe that it is too invasive as a first line diagnostic measure when similar accuracy can be achieved without an operation. The guidelines of the European Association for Endoscopic Surgery state that diagnostic laparoscopy can be useful for patients with acute abdominal pain, but that noninvasive diagnostic aids should be exhausted first[35].

The data presented in chapters 2-6 was collected during a project at the Rode Kruis Hospital (currently HAGA hospital) in the Hague from June 2005 until July 2006. This prospective cohort investigation (DIBAB study – '**Di**agnostiek **b**ij **a**cute **b**uik') was initiated in order to address some clinical issues concerning the diagnosis and management of acute abdominal pain. Our strategy was based on a premise that the least detrimental and non-invasive diagnostic modalities should always come first for diagnosing and managing patients with acute abdominal pain at the emergency department. - Primum non nocere. The last chapter is a review that embodies this same principle.

Outline of the thesis

Some of the patients presenting at the emergency department with acute abdominal pain can be easily recognized to require a hospital admission for surgical or medical treatment. When evaluating other patients it may be more challenging to distinguish urgent surgical diagnoses from non-surgical or self-limiting pathology. Additional radiological imaging may facilitate the diagnosis for some but preferably not all of these patients with equivocal abdominal pain. Outpatient re-evaluation is often used to differentiate mild disease from surgical pathology in equivocal cases. In **chapter 2** an assessment is made of the efficacy and safety of standard outpatient re-evaluation for patients that present with acute abdominal pain at the emergency department but who are not considered to require a hospital admission. The hypothesis is that standard outpatient re-evaluation for patients with equivocal abdominal pain is safe, can improve diagnostic accuracy, and will facilitate proper treatment selection.

When patients are clinically suspected to have acute appendicitis, additional radiological imaging such as ultrasound and CT, and diagnostic laparoscopy have been shown to improve diagnostic accuracy and avoid negative appendectomies[36-39]. In our opinion, the use of non-invasive modalities such as clinical evaluation, ultrasound and clinical re-evaluation should be the preferred method for diagnosing acute appendicitis. CT and diagnostic laparoscopy should only be used if these less detrimental modalities do not suffice. In **chapter 3** a diagnostic strategy for appendicitis is tested using non-invasive methods with a minimal use of complementary CT (ionizing radiation) and diagnostic laparoscopy.

Making an accurate diagnosis for children that present with acute abdominal pain can also be challenging. There are some self-limiting diseases that mimic acute appendicitis quite accurately, and the most common is acute mesenteric lymphadenitis[40]. Acute mesenteric lymphadenitis is a self-limiting disorder that has been a common finding during negative surgical explorations for acute abdominal pain in children[41] and is frequently diagnosed when patients undergo additional radiological imaging for suspected appendicitis[42]. In **chapter 4** we investigate whether it is possible to clinically

distinguish acute appendicitis from acute mesenteric lymphadenitis in children. Our hypothesis is that this is not possible and that additional imaging is necessary for an accurate diagnosis.

When children with acute abdominal pain are referred to the radiologist for additional imaging at our institution, ultrasound is the primary investigation of choice[43]. While performing these ultrasound investigations for appendicitis in children, it is not always possible for the radiologist to visualize the appendix. In **chapter 5** we investigate the value of secondary signs of acute appendicitis during abdominal ultrasound for suspected appendicitis in children.

In **chapter 6** the diagnostic accuracy of clinical evaluation, ultrasound and CT is investigated for patients with suspected colonic diverticulitis at the emergency department. The hypothesis is that clinical evaluation is insufficient, and that additional radiological imaging is necessary for an accurate diagnosis. The aim is also to assess what impact these examinations have on clinical decision making.

The majority of patients diagnosed to have acute colonic diverticulitis at the emergency department can be treated conservatively. However, for patients presenting with generalized peritonitis due to perforated colonic diverticulitis the recommended treatment is an urgent colonic (sigmoid) resection. Regardless of the technique, a colectomy is associated with a substantial morbidity and mortality in these cases. Recently, several articles have reported laparoscopic peritoneal lavage, drainage and antibiotics as an alternative to acute colonic resection. In **chapter 7** a systematic review of the available literature evaluates the efficacy, mortality and morbidity of laparoscopic peritoneal lavage for patients presenting with acute perforated colonic diverticulitis.

References

1. Powers RD, Guertler AT. Abdominal pain in the ED: stability and change over 20 years. Am J Emerg Med 1995; 13:301-303.
2. Laurell H, Hansson LE, Gunnarsson U. Diagnostic pitfalls and accuracy of diagnosis in acute abdominal pain. Scand J Gastroenterol 2006; 41:1126-1131.
3. Birnbaum BA, Wilson SR. Appendicitis at the millennium. Radiology 2000; 215:337-348.
4. Laurell H, Hansson LE, Gunnarsson U. Acute diverticulitis--clinical presentation and differential diagnostics. Colorectal Dis 2007; 9:496-501.
5. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med 1986; 15:557-564.
6. Samuel M. Pediatric appendicitis score. J Pediatr Surg 2002; 37:877-881.
7. Bhatt M, Joseph L, Ducharme FM et al. Prospective validation of the pediatric appendicitis score in a Canadian pediatric emergency department. Acad Emerg Med 2009; 16:591-596.
8. Goldman RD, Carter S, Stephens D et al. Prospective validation of the Pediatric Appendicitis Score. Journal of Pediatrics 2008; 153:278-282.
9. Schneider C, Kharbanda A, Bachur R. Evaluating appendicitis scoring systems using a prospective pediatric cohort. Annals of Emergency Medicine 2007; 49:778-784.
10. Laméris W, Bakker OJ, van Randen A et al. Selection of patients with a high probability for acute appendicitis by clinical assessment compared with clinical scoring systems. In: Diagnostic strategies for acute abdominal pain: the OPTIMA study. [S.l. : s.n.]; 2010:77-94.
11. Adams ID, Chan M, Clifford PC et al. Computer aided diagnosis of acute abdominal pain: a multicentre study. Br Med J (Clin Res Ed) 1986; 293:800-804.
12. Sutton GC. Computer-aided diagnosis: a review. Br J Surg 1989; 76:82-85.
13. Sutton GC. How accurate is computer-aided diagnosis? Lancet 1989; 2:905-908.
14. Cooper JG, West RM, Clamp SE et al. Does computer-aided clinical decision support improve the management of acute abdominal pain? A systematic review. Emerg Med J 2010.
15. Puylaert JB. Ultrasonography of the acute abdomen: gastrointestinal conditions. Radiol Clin North Am 2003; 41:1227-42, vii.
16. Allemann F, Cassina P, Rothlin M et al. Ultrasound scans done by surgeons for patients with acute abdominal pain: a prospective study. Eur J Surg 1999; 165:966-970.
17. van Randen A, Bipat S, Zwinderman AH et al. Acute appendicitis: meta-analysis of diagnostic performance of CT and graded compression US related to prevalence of disease. Radiology 2008; 249:97-106.
18. Hollerweger A, Macheiner P, Rettenbacher T et al. Colonic diverticulitis: diagnostic value and appearance of inflamed diverticula-sonographic evaluation. Eur Radiol 2001; 11:1956-1963.

19. Ripolles T, Agramunt M, Martinez MJ et al. The role of ultrasound in the diagnosis, management and evolutive prognosis of acute left-sided colonic diverticulitis: a review of 208 patients. Eur Radiol 2003; 13:2587-2595.
20. Pradel JA, Adell JF, Taourel P et al. Acute colonic diverticulitis: prospective comparative evaluation with US and CT. Radiology 1997; 205:503-512.
21. Schwerk WB, Schwarz S, Rothmund M. Sonography in acute colonic diverticulitis. A prospective study. Dis Colon Rectum 1992; 35:1077-1084.
22. Verbanck J, Lambrecht S, Rutgeerts L et al. Can sonography diagnose acute colonic diverticulitis in patients with acute intestinal inflammation? A prospective study. J Clin Ultrasound 1989; 17:661-666.
23. Hollerweger A. Colonic diseases: the value of US examination. Eur J Radiol 2007; 64:239-249.
24. Rosen MP, Sands DZ, Longmaid HE, III et al. Impact of abdominal CT on the management of patients presenting to the emergency department with acute abdominal pain. AJR Am J Roentgenol 2000; 174:1391-1396.
25. Gerhardt RT, Nelson BK, Keenan S et al. Derivation of a clinical guideline for the assessment of nonspecific abdominal pain: the Guideline for Abdominal Pain in the ED Setting (GAPEDS) Phase 1 Study. Am J Emerg Med 2005; 23:709-717.
26. Ambrosetti P, Grossholz M, Becker C et al. Computed tomography in acute left colonic diverticulitis. Br J Surg 1997; 84:532-534.
27. Cho KC, Morehouse HT, Alterman DD et al. Sigmoid diverticulitis: diagnostic role of CT--comparison with barium enema studies. Radiology 1990; 176:111-115.
28. Brenner DJ, Hall EJ. Computed tomography--an increasing source of radiation exposure. N Engl J Med 2007; 357:2277-2284.
29. Hall EJ, Brenner DJ. Cancer risks from diagnostic radiology. Br J Radiol 2008; 81:362-378.
30. Stoker J, van Randen A, Lameris W et al. Imaging patients with acute abdominal pain. Radiology 2009; 253:31-46.
31. Cobben L, Groot I, Kingma L et al. A simple MRI protocol in patients with clinically suspected appendicitis: results in 138 patients and effect on outcome of appendectomy. Eur Radiol 2009; 19:1175-1183.
32. Cobben LP, Groot I, Haans L et al. MRI for clinically suspected appendicitis during pregnancy. AJR Am J Roentgenol 2004; 183:671-675.
33. Vander Velpen GC, Shimi SM, Cuschieri A. Diagnostic yield and management benefit of laparoscopy: a prospective audit. Gut 1994; 35:1617-1621.
34. Paterson-Brown S. Emergency laparoscopic surgery. Br J Surg 1993; 80:279-283.
35. Sauerland S, Agresta F, Bergamaschi R et al. Laparoscopy for abdominal emergencies - Evidence-based guidelines of the European Association for Endoscopic Surgery. Surgical Endoscopy and Other Interventional Techniques 2006; 20:14-29.

36. Rao PM, Rhea JT, Rattner DW et al. Introduction of appendiceal CT: impact on negative appendectomy and appendiceal perforation rates. Ann Surg 1999; 229:344-349.
37. Bendeck SE, Nino-Murcia M, Berry GJ et al. Imaging for suspected appendicitis: negative appendectomy and perforation rates. Radiology 2002; 225:131-136.
38. Moberg AC, Ahlberg G, Leijonmarck CE et al. Diagnostic laparoscopy in 1043 patients with suspected acute appendicitis. European Journal of Surgery 1998; 164:833-840.
39. Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev 2004;CD001546.
40. Puylaert JB. Mesenteric adenitis and acute terminal ileitis: US evaluation using graded compression. Radiology 1986; 161:691-695.
41. Gilmore OJ, Browett JP, Griffin PH et al. Appendicitis and mimicking conditions. A prospective study. Lancet 1975; 2:421-424.
42. Rao PM, Rhea JT, Novelline RA. CT diagnosis of mesenteric adenitis. Radiology 1997; 202:145-149.
43. van den Ende ED, Boellaard WP, Allema JH et al. [Diagnostic surplus value of echography in children with acute abdominal pain]. Ned Tijdschr Geneeskd 2003; 147:1174-1177.