Magnetic resonance imaging in acute appendicitis
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Chapter 2

Imaging of patients with clinically suspected appendicitis in the Netherlands: conclusions of a survey

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Julien Puijlaert
Lucas Kingma
Hans Blickman

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Abstract

The aim of this study was to summarize the extent of variation in imaging strategies in patients clinically suspected of appendicitis. By means of a written survey the policies for the imaging management of patients clinically suspected of having appendicitis in the Netherlands were inventoried. A questionnaire was sent to both the departments of surgery and radiology of all 105 Dutch hospitals, including the 8 academic medical centers, in March 2006. Questionnaires were returned from 98 hospitals. It was found that in the work-up of patients suspected of appendicitis US or CT was performed in a minority of hospitals in 50% or more of these patients. In a large majority of hospitals it was carried out in less than 50% of these patients. There is a widespread variability in preoperative imaging regardless of hospital type. This survey shows that despite the ubiquitous presence of US and CT in Dutch hospitals, the preoperative imaging work-up in patients clinically suspected of having acute appendicitis does not reflect this, only being performed in a minority of patients suspected of acute appendicitis. Radiologists and surgeons alike should be aware of the positive impact of adjunctive imaging in this group of patients in most importantly lowering the negative appendectomy rate and also lowering total hospital costs.
Introduction

Acute appendicitis is the most common cause of acute abdominal right lower quadrant pain and for emergency abdominal surgery. Early and accurate diagnosis of acute appendicitis is crucial for clinical decision-making. Unnecessary surgery, clinical delay or hospitalization can thus often be avoided [1, 2].

Because of a traditionally high false negative appendectomy rate (8-50%) [1-3] in patients suspected of having appendicitis, an imaging evaluation to confirm or exclude the diagnosis of appendicitis is often performed [1-3].

Trans-abdominal ultrasound (US) and abdominal computed tomography (CT) have proven to be reliable procedures in detecting or excluding appendicitis with reported sensitivity and specificity of more than 90% [4] [5, 6].

These imaging modalities are widely available in the Netherlands, yet there are growing concerns regarding the appropriate use of these imaging modalities in evaluation of patients clinically suspected of having appendicitis. In a recent personal communication in the Dutch Medical Journal, surgeons argued that adjunctive pre-operative imaging in acute appendicitis is contra-indicated, in contrast to the guidelines of the Dutch Society of Surgery [7]. Personal experience and communication with colleagues at national and international congresses also indicates that there is a wide variety in the use of pre-operative imaging in patients with suspected appendicitis. Current imaging policies are usually based on consensus meetings, expert opinions, study outcomes, and personal and/or institutional preferences. All these result in variable and thus inconsistent choices in imaging strategies between specialists and institutions. We decided to inventory the nature and extent of this proposition.

By means of a written survey, we inventoried the policies for the imaging management of patients clinically suspected of having appendicitis in the Netherlands. The primary aim of this survey was to summarize the extent of variation in these imaging strategies; the secondary aim was to evaluate the main reasons for these
differences and, lastly, what, if anything, can/should be suggested with the patients health in mind.

Materials and Methods

A written survey on the management of patients clinically suspected of having appendicitis was sent to both the departments of surgery and radiology of all 105 Dutch hospitals, including the 8 academic medical centers, in March 2006. All these hospitals were equipped with emergency departments, CT-scan and US equipment and performed appendectomies. Prepaid stamped return envelopes were provided and collected until August 2006.

The survey was in the form of a multiple-choice questionnaire. Due to different medical specialties being surveyed the questionnaire was divided into three parts:
1. A general part, where questions were asked about the type of hospital: general hospital (GH), teaching hospital with or without radiology residents (THR+/THR-), or academic medical center (AH).
2. A diagnostic part, where information on the diagnostic work-up and the use of different imaging modalities was requested; Surgeons were asked about the percentage of patients suspected of appendicitis in whom pre-operative imaging (CT or US) was asked for, and radiologists were asked about the first choice of imaging modality (US or CT) and the percentage of patients in whom CT is performed after unequivocal US.
3. An evaluation part, where questions were asked about factors influencing the choice for diagnostic imaging in patients clinically suspected of having appendicitis. Surgeons were asked why preoperative imaging was requested; a. because of clinical doubt or b. because it was part of a standard procedure in patients suspected for appendicitis. Surgeons were also asked about the reasons to decide not to perform preoperative imaging; a. because it has no additional value to the clinical acumen, b.
imaging is too operator dependent, c. due to logistical problems, it was not possible, d. pre-operative imaging causes too much delay in diagnostic work-up or e. other reasons.

### Results

#### 1. General results

There was a very high response rate. Questionnaires were returned from 98 hospitals out of 105: 48 GH, 17 THR+, 25 THR-, and all 8 AH. Ninety-seven (92%) and 90 (86%) replies were returned from the Departments of surgery and radiology, respectively.

#### 2. Imaging results

In table 1 it is shown that there is wide variability in pre-operative imaging in suspected appendicitis. This difference is not related to type of hospital, but is seen in all types of hospitals. In 35 out of 48 GH (73%), 10 out of 17 THR+ (59%), 19 out of 25 THR- (76%) and 4 out of 8 AH (50%) preoperative imaging is performed in less than 50% of patients suspected of having appendicitis. When all hospitals are taken together in 68% of hospitals preoperative imaging is performed in less than 50% of these patients. Moreover, in total in 12 hospitals (12%) there is no imaging performed at

<table>
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<th>hospital type</th>
<th>% of pt in whom preoperative imaging is performed</th>
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<tbody>
<tr>
<td></td>
<td>&lt;5%</td>
</tr>
<tr>
<td>GH</td>
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</tr>
<tr>
<td>THR+</td>
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<td>THR-</td>
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<tr>
<td>AH</td>
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</tr>
<tr>
<td>total</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 1. Number of hospitals related with percentages of patients clinically suspected of having appendicitis in whom preoperatively an imaging work-up (CT or US) was done. GH = general hospital, THR+ = teaching hospital with radiology residents, THR- = teaching hospital without radiology residents and AH is academical center.
all, whereas in 10 (10%) in almost all patients.

When imaging was done, US is a first choice imaging modality in almost all hospitals whereas CT is first choice in only in 3 hospitals. In table 2 it is shown that when US results were equivocal, thus couldn’t prove nor exclude appendicitis or an alternative diagnosis, there was also a large variability in performing subsequent CT in this subgroup of patients. In 20 out of 41 GH (49%), 11 out of 17 THR+ (65%), 13 out of 26 THR- (50%) and 3 out of 4 AH (75%) subsequent CT was done in order to exclude or detect appendicitis.

<table>
<thead>
<tr>
<th>hospital type</th>
<th>% of pt in whom CT is performed after inconclusive US</th>
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<tbody>
<tr>
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</tr>
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<td>AH</td>
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<tr>
<td>total</td>
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</table>

Table 2. Number of hospitals related with the percentages of patients in whom a subsequent CT is performed when the initial US findings where equivocal in detecting or excluding appendicitis. GH = general hospital, THR+ = teaching hospital with radiology residents, THR- = teaching hospital without radiology residents and AH = academic (medical) center.

3. Evaluation part results

In table 3 the reasons for performing preoperative imaging in patients suspected of appendicitis are given. The main reason, irrespective of hospital type, was clinical doubt by the surgeon or surgical resident. Radiological evaluation in patients suspected of having appendicitis was performed because of clinical doubt by the surgeon or surgical resident in 79 hospitals (43 GH, 14 THR+, 19 THR-, 3 AH). Only in a minority of 15 hospitals was preoperative imaging part of a standard protocol in this group of patients (3 GH, 3 THR+, 6 THR-, 3 AH), and again independent of hospital type.
In table 4 reasons not to perform preoperative imaging are given. The main reasons given were: lack of additional value over the clinical signs according to the surgeons in 63 hospitals (33 GH, 11 THR+, 17 THR-, 2 AH)); the imaging (US) was found to be too operator dependent in 34 hospitals (18 GH, 2 THR+, 13 THR-, 1 AH); logistical problems in 9 hospitals (2 GH, 1 THR+, 3 THR-, 3 AH); or too much delay in diagnostic work-up in 11 hospitals (6 GH, 1 THR+, 4 THR-, 0 AH).

### Table 3. Reasons for performing preoperative imaging related with number of hospitals. GH = general hospital, THR+ = teaching hospital with radiology residents, THR- = teaching hospital without radiology residents and AH is academical center.

<table>
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<th>hospital type</th>
<th>Imaging +</th>
</tr>
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<td></td>
<td>clinical doubt</td>
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<tr>
<td>GH</td>
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<td>THR+</td>
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<td>AH</td>
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<tr>
<td>total</td>
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**Discussion**

GH, general hospital; THR+, teaching hospital with radiology residents; THR–, teaching hospital without radiology residents; AH, academic centre.

The clinical presentation of appendicitis is often confusing. Even in patients with clinically high suspicion of appendicitis, a normal appendix is surgically removed in 5-50% of patients [8]. Several reports conclude that diagnostic imaging should also be performed in patients with a clinical high probability of acute appendicitis, because it accurately depicts a high percentage of normal appendices and differential diagnoses [9]. There are numerous abdominal conditions, common and uncommon, that can mimic the clinical conditions of appendicitis and these patients form a substantial part of all patients presenting at the emergency department with acute abdominal pain[2]. Reports also conclude that trans-abdominal US and abdominal CT have the ability to detect or exclude appendicitis with a reported sensitivity and specificity of more than 90% [10].
In a landmark study by Rao et al [12], it was shown that routine appendiceal CT performed in patients who present with suspected appendicitis improves patient care and reduces the use of hospital resources. One could even argue that the use of US as a primary imaging modality would even be more cost-effective [13].

Additionally, in a recent article by Bijnen et al. the removal of a normal appendix was shown to be associated with considerable complications and costs. In an attempt to prevent these costs, extra diagnostic tools should be considered. Expensive diagnostic tools such as diagnostic laparoscopy should be used selectively in order not to further increase costs. [1]

To summarize one could state that an increase in pre-operative imaging in patients suspected of appendicitis can significantly lower the negative appendectomy rate. However, some difficulties are encountered in making this assumption. First, in hospitals where diagnostic laparoscopies are performed in patients suspected of appendicitis and where a normal appendix is encountered and left in situ, low negative

<table>
<thead>
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<th>hospital type</th>
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<th>Imaging – operator dependent</th>
<th>logistics</th>
<th>time loss</th>
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<tbody>
<tr>
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<td>33</td>
<td>18</td>
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<td>6</td>
</tr>
<tr>
<td>THR+</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>THR-</td>
<td>17</td>
<td>13</td>
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<td>4</td>
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<tr>
<td>AH</td>
<td>2</td>
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<td>0</td>
</tr>
<tr>
<td>total</td>
<td>63</td>
<td>34</td>
<td>9</td>
<td>11</td>
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</tbody>
</table>

Table 4. Reasons for lack of preoperative imaging related with number of hospitals. GH = general hospital, THR+ = teaching hospital with radiology residents, THR- = teaching hospital without radiology residents and AH is academical center.
appendectomy rates in combination with low pre-operative imaging rates can be the result. Secondly, when imaging is performed after accurate selection of the patients, imaging might be very useful in selecting the true negatives. This way the use of imaging does not increase but the number of negative appendectomies decreases. Critics will argue that imaging has not caused the lower negative appendectomy rate because the amount of imaging has not changed.

Besides the negative appendectomy rate, pre-operative imaging is not only about detecting a normal or inflamed appendix, but also about detecting a significant amount of alternative diagnoses.

In the Netherlands there is a widespread proliferation of US equipment and modern multislice CT scanners and de facto, all Dutch hospitals performing appendectomies are in the possession of these machines. The Netherlands is a relatively small country with a National Health service, excellent facilities, increase use of national evidence based guidelines and there has been a debate for advancement of pre-operative imaging for years. Moreover, in the light of these facilities and developments the results of our survey are very surprising. The availability of CT and US may be assumed to be present also in the rest of the Western world, but the authors realize that the results of our survey are not applicable to many countries with fewer facilities.

The results of our study show that in the work-up of patients suspected of appendicitis US or CT was performed in more than 50% of these patients only in a minority of hospitals (30 out of 98). More importantly, however, in a large majority of 68 out of 98 hospitals it was carried out in less than 50% of these patients. Also a widespread variability in preoperative imaging regardless of hospital type was found.

There are 4 types of hospitals in the Netherlands; general hospitals, teaching hospitals with and teaching hospitals without radiology residents and academical medical centers. The latter are tertiary referral centers and are major teaching centers; the former can be of varying sizes. Radiology residents are not available in all teaching hospitals, but all teaching hospitals do have surgical residents.
There are several reasons given for not performing any or only selective imaging. Firstly, an important reason given by the referring surgeons was lack of added value to the clinical findings, irrespective of whether or not the clinical findings were evident for acute appendicitis. As mentioned previously, on the grounds of recent studies this can no longer be stated. Surgeons and radiologists alike should be aware of these facts, so as to both optimize the work-up of these patients and save costs.

The second argument was that the pre-operative imaging is too operator dependent to be relied on by the referring physician. For US this is an often-used argument. However, in a recent study it was shown that when mis-classifications were compared with the definite alternative diagnosis, there were no significant differences between US and CT, or between groups of radiologists, regardless of patient age or patient sex [14]. A Dutch report shows that when US findings are equivocal in patients with suspected appendicitis, an additional CT significantly lowers the negative appendectomy rate as compared to the clinical acumen alone, without negative effect on perforation rate [15]. In our survey it was shown that in 40 out of 88 hospitals subsequent CT was done in less than 50% of patients and in 48 out of 88 hospitals in more than 50% of these patients when the initial US study was equivocal.

A third argument not to perform preoperative imaging is loss of important time with the adverse effects on the perforation rate or the in-hospital delay. In our survey this was stated in 11 hospitals. However, numerous studies have acknowledged that preoperative imaging has no adverse effects on perforation rate or in-hospital delay, if performed within a reasonable period of time [3, 15]. In Dutch hospitals logistic problems are only encountered in a minority of hospitals.

In conclusion, this survey shows that despite the ubiquitous presence of US and CT in Dutch hospitals, the preoperative imaging work-up in patients clinically suspected of having acute appendicitis does not reflect this, being performed only
in a minority of patients suspected of acute appendicitis. Radiologists and surgeons alike should be aware of the possible positive impact of additional imaging in this group of patients in order to increase the diagnostic accuracy, lower the negative appendectomy rate, detecting alternative diagnoses and eventually lower total hospital costs.
References