Received:
08 February 2018

Revised:
14 May 2018

Accepted:
22 May 2018

<https://doi.org/10.1259/bjr.20180158>

Cite this article as:
de Burlet KJ, MacKay M, Larsen P, Dennett ER. Appropriateness of CT scans for patients with non-traumatic acute abdominal pain. *Br J Radiol* 2018; **91**: 20180158.

FULL PAPER

Appropriateness of CT scans for patients with non-traumatic acute abdominal pain

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Objective: Acute abdominal pain is the most common reason for surgical admission. CT scans are increasingly used to aid early diagnosis. Excessive use of CT scans is associated with increased length of stay, healthcare costs and radiation. The aim of this study was to evaluate the appropriateness of CT scans for patients presenting with acute abdominal pain.

Methods: We examined 100 consecutive patients presenting with new acute abdominal pain who underwent a CT scan. Clinical information available at the time the scan was ordered, was summarised and reviewed independently by five consultant general surgeons and five consultant radiologists.

Results: A CT scan was judged to be not indicated in a median of 21% of cases (range 12–53%), more information

was required in a median of 16% (0–41%) and in a median of 58% (37–88%) the CT scan was considered indicated. There was a good level of agreement (Cronbach's α 0.704) across the 10 experts.

Conclusion: These data suggest that a large proportion of CT scans for patients with acute abdominal pain are not clinically indicated or are being performed prior to adequate clinical work-up. Optimising CT scan requests for this patient group will improve use of healthcare resources.

Advances in knowledge: Both radiologists and general surgeons agree that there is no indication for an abdominal CT scan for a patient presenting with acute abdominal pain in a median of 21% of the cases.

INTRODUCTION

Acute abdominal pain accounts for 5–10% of all presentations to the emergency department (ED) and can be caused by a variety of diseases ranging from mild and self-limiting to life threatening.¹ Rapid and accurate diagnosis in life threatening conditions is of vital importance to start treatment as soon as possible to ensure the best possible outcomes. On the other hand, early recognition of patients with self-limiting problems is a priority in order to optimise use of limited healthcare resources.

The use of CT scans to aid diagnosis in patients presenting with abdominal pain has increased over the last decade. It is associated with a high diagnostic accuracy with a sensitivity and specificity of approximately 90–95%.^{2–6} However, to date, there is no convincing evidence that this increase in diagnostic accuracy also leads to a reduction in final outcomes such as length of stay, complications and mortality for patients presenting with acute abdominal pain. Furthermore, the use of this diagnostic tool also has downsides. Imaging can lead to higher costs and delay in

diagnosis due to long waiting times to obtain a CT scan.⁷ Other risks include contrast allergies, contrast-induced nephropathy and ionising radiation exposure.^{8,9} Ensuring appropriate and not excessive use of CT scans in this patient population is, therefore, a priority.

A recent study showed that over a decade, there was a significant increase in the number of scans being performed for patients presenting to the ED with new and acute abdominal pain. The review also showed that an increasing proportion of these scans were negative for acute pathology.¹⁰

The aim of this study was to evaluate our institutions' (Wellington hospital) CT scan requests for patients presenting with acute and new abdominal pain and to determine how many of these scans were considered clinically indicated.

METHODS AND MATERIALS

This study was performed in a large tertiary centre in New Zealand. Data were collected for 100 consecutive CT scans

meeting inclusion criteria for inpatients in the general surgical department starting from the 1 January 2016. Patients were included if they had a CT scan for new abdominal pain within 2 days of their admission. Patients who had post-operative scans (all scans for patients within 30 days from their operation or for pathology directly associated to an operation within 90 days), pain for more than 7 days before admission or were admitted because of trauma, were excluded.

A summary was written about the patient's initial presentation. The summary included: age, gender, relevant medical history, duration of symptoms, location of pain, accompanying symptoms (*e.g.* nausea, vomiting and bowel motions), findings on examination (including localised pain or presence of peritonism), any abnormal blood results and abnormal findings on plain X-ray. These summaries were generated from ED notes, admission notes, CT scan request forms and admission blood results. Summaries were written by one author (senior registrar, 8 years post-graduation) and reviewed by a second author (consultant general surgeon and associate professor). The cases did not contain patient identification details (such as patient number, date of birth or name) nor was the outcome of the scan mentioned in the summary.

Five consultant general surgeons and five consultant radiologists were asked to independently review the 100 selected cases. On the basis of the patient summary, the reviewer was asked whether a CT scan was indicated and if yes whether this scan was urgent (perform within 12 h) or non-urgent. If the reviewer thought the CT scan was not indicated, they were asked whether another imaging modality was more appropriate or not. Alternatively, they could state whether they required more clinical information in order to make any decision (Figure 1). Decisions on whether the scan was indicated or not were based on the clinicians

experience. No appropriateness criteria (*e.g.* the appropriateness criteria of the American College of Radiologists¹¹) were used, because it was considered that these were not applicable to all cases.

The results were analysed by two different methods. Firstly, the individual answers given by each participating consultant were evaluated and secondly, each case (representing a patient who had an abdominal CT scan) was grouped according to the majority decision. In the latter analysis, the cases were divided into three groups. Group 1, where five or more consultants agreed that there was no indication for the CT scan, Group 2, where consultants did not agree about the indication of a scan or Group 3, where five or more consultants agreed that the CT scan was indicated.

The patient characteristics (gender and age), relevant medical history, findings on examination and blood results [White Cell Count (WCC) and C-Reactive Protein (CRP)] were compared between the three groups.

The outcomes of the scans and the final diagnosis (at the time of discharge) were collected and compared with the decisions about the indication of the scan of the experts. A scan was considered positive for acute/new pathology, when the CT demonstrated pathology that could explain the patient's symptoms.

This study design was proposed to and approved by the Health and Disability Ethics Committee in New Zealand (reference: 16/NTB/131).

The data were statistically analysed using SPSS® software (SPSS 23, Chicago, IL). Data are expressed as mean and standard deviation for normally distributed continuous data, median (range) for non-parametric data and count (%) for discrete data. Continuous

Figure 1. Example of a case summary. CRP, C-reactive protein; LIF, left iliac fossa; WCC, white cell count.

87yr old male, no relevant medical history. Presents with 3 days of LIF pain, lack of appetite, rigors. Examination: distended abdomen, tender in LIF, localised peritonitis. WCC: 14.5, CRP: 190

- ☐ Need more information to make a decision
- ☐ No indication for a CT scan
 - ☐ Other imaging modality more appropriate
 - ☐ Imaging not needed prior to starting definitive treatment
- ☐ Indication for CT scan
 - ☐ Urgent CT scan
 - ☐ Non-urgent CT scan (24-48hrs)
 - ☐ CT scan as outpatient

Table 1. Specialist answers

	Surgeons					Radiologists				
	1	2	3	4	5	1	2	3	4	5
Not indicated	20	21	36	31	12	39	22	12	18	53
Other modality	7	13	26	20	8	23	12	9	13	36
Not indicated	13	8	10	11	4	16	10	3	5	17
Indicated	72	65	48	52	58	52	37	88	65	47
Urgent	49	22	10	36	10	26	12	3	4	18
Non urgent	23	43	38	16	48	26	25	85	61	29
More information	8	14	16	17	30	9	41	0	17	0

Summary of individual answers per specialist adding up to 100 cases.

data were compared between groups using One-Way ANOVA for normally distributed data. χ^2 tests were used for discrete data. Reliability analysis was used to calculate the Cronbach's α to determine the level of agreement among the specialists. A p -value of ≤ 0.05 was considered statistically significant.

RESULTS

In total, 100 cases were selected out of the first 314 abdominal CT scans that were performed from 1 January 2016. The majority of the cases were excluded because they were requested for patients that had a complication after an operation, had a scan related to a recent trauma or had pain for more than 7 days. Of the 100 case summaries reviewed, the specialists reported that the CT scans were not indicated in a median of 21% (range 12–39%), more information was required in a median of 16% (range 0–41.0%) and in a median of 58% (range 37–88%) the CT scan was indicated (Table 1). When the CT scan was indicated, a median of 33% (range 3–69%) were considered urgent. Of the CT scans that were not indicated another imaging modality was thought to be more appropriate in a median of 66% (range 35–75%).

When results were analysed based on the majority decisions Group 1 (CT not indicated) comprised 20% of the cases, Group 2 (CT maybe indicated) 13% and Group 3 (CT indicated) the remaining 67%. Patients in Group 3, were statistically significantly older ($p = 0.003$), were more likely to have peritonism or a palpable mass on examination ($p = 0.017$) and were more likely to have

a raised CRP ($p = 0.050$), compared to the patients in the other two groups. Gender, a relevant medical history and a raised WCC were not associated with the indication for CT scan (Table 2).

The cases in Group 2 were more commonly rated as requiring additional information to make a decision (median of three consultants saying this per case) compared to those in groups 1 and 3 (median of one consultant saying this per case in each of these groups, $p = 0.001$).

New pathology was found in 55.0% in Group 1, 76.9% in Group 2 and 83.6% in Group 3 ($p = 0.029$). Of the 20 patients in Group 1, where a CT scan was considered not indicated by 10 specialists, 9 (45.0%) had no pathology on the scan that could explain the patients symptoms. 11 patients (55.0%) did have new pathology on the scan, 5 patients had cholecystitis, 3 patients uncomplicated diverticulitis, 1 patient uncomplicated colitis (of the ascending colon), 1 patient had a partial small bowel obstruction and one patient had uncomplicated appendicitis. All of them, except the patient with appendicitis, were treated conservatively. The appendicitis case, had an atypical presentation with inflammatory markers (WCC and CRP) within normal range and she was of older age (51-years-old).

The calculated value of agreement (Cronbach's α) between the 10 consultant specialists about the indication of the CT scan was 0.704.

Table 2. Group characteristics

	CT not indicated (N = 20)	CT may be indicated (N = 13)	CT indicated (N = 67)	<i>p</i> -value
Age [mean, (SD)]	48 (19)	56 (20)	62 (14)	0.003
Gender				
Male	11 (55%)	5 (39%)	33 (49%)	0.648
Relevant medical history				
Yes	7 (35%)	9 (69%)	40 (60%)	0.087
Examination				
Peritonism or mass	1 (5%)	2 (15%)	20 (30%)	0.017
Raised WCC ($>12.0 \times 10^9 \text{ l}^{-1}$)	9 (45%)	1 (8%)	26 (39%)	0.620
Raised CRP ($>25 \text{ mg l}^{-1}$)	7 (35%)	5 (39%)	38 (57%)	0.050

WCC, white cell count (10^9 l^{-1}); CRP, C-reactive protein (mg l^{-1}).

DISCUSSION

The results of this study suggests that a significant proportion of CT scans in patients with acute abdominal pain are not clinically indicated or are being performed prior to adequate clinical workup.

One-fifth of the CT scans were considered not indicated when analysed by the individual specialist as well as when grouping the specialists to obtain a majority decision per individual case. 11 patients (55.0%) in this group, did however have new pathology on the scan. All, except one patient, had relatively benign diagnoses and were treated conservatively. With a more thorough work-up, these scans might not have been indicated. Five patients had cholecystitis which correlates with the results that in a median of 66% of the cases where the specialists thought a CT was not indicated, but another imaging modality was considered more appropriate (usually an ultrasound scan). The reason why a CT scan was requested and not an ultrasound, is difficult to explain from these results. It is possible that ultrasound is perceived as more difficult to obtain, so a CT scan is requested instead. Another reason might be that due to body habitus a CT scan was preferred over an ultrasound.¹²

Specialists were more likely to agree about the indication for a CT scan when the patients were older, had peritonism or a mass found on examination or when they had a raised CRP. Significantly more specialists indicated that they required more information for patients in Group 2 (CT may be indicated), before they could make a decision. This result implies that patients in Group 2 required a more intensive work-up prior to requesting the scan. In most cases, a longer observation on the ward and repeat blood test the next day could have helped the clinician in determining whether this patient would need a CT scan to aid the diagnostic process or whether the patient's symptoms were benign and a CT scan would not be necessary.

There are a number of studies that have looked at routine imaging and the diagnostic accuracy for patients presenting with acute abdominal pain to the ED. These studies show that routine imaging is associated with approximately 40% of the scans being negative for acute pathology.^{2,12-14} A recent study, in a comparable healthcare system to ours, showed that routine imaging is associated with increased cost and longer length of hospital stay compared to selective imaging at all ages. They concluded that routine CT cannot be recommended for unselected patients with acute abdominal pain.⁷ This is also supported by the world wide initiative, "Choosing Wisely", which promotes the thoughtful use of hospital resources particularly in the ED. Despite this introduction, specialists struggle with the uncertainty and patient expectations, even

though the evidence supports a higher risk tolerance and a less defensive approach.¹⁵

There was a good level of agreement amongst the 10 specialists from the 2 specialties. This finding supports that both departments should further investigate the appropriateness of the CT scan requests in our hospital. The authors are aiming to do this by introducing a diagnostic pathway for patients presenting with abdominal pain to the ED. Part of this pathway is an improved and standardised work up of the patients, a senior review and a verbal discussion with the on call radiologists prior to requesting an abdominal CT scan.

A limitation of the design of the study was that case summaries were made retrospectively on the basis of the available documentation from ED, the admission, laboratory results and the CT request form. Information might have been misinterpreted or missed due to this design. The case summaries in this study were formatted as an "ideal" radiology order with adequate patient information. The amount of information given in radiology orders is directly related to the accuracy of the report.^{16,17} This study, however, did not assess the accuracy of the radiology orders. Also, this study was performed in a tertiary centre in New Zealand, although none of the cases described were referrals from other hospitals, the patient population may differ from other institutions. The consultants were asked to review 100 cases, this number was chosen empirically by the authors as the volume enabled comparison both between cases and between the consultants and represented a reasonable representation of the clinical workload.

CONCLUSION

There was no indication for an abdominal CT scan in one-fifth of all requests. In a majority of these patients, no CT was necessary according to both radiologists and surgeons, although in 66% of these cases another imaging modality was considered more appropriate (usually ultrasound). Based on these results, we recommend that a more critical review may be required prior to ordering CT scans for patients presenting with acute abdominal pain, particularly in younger patients, those without peritonism or elevated CRP results. This will reduce the number of unnecessary scans and, thereby, reduce patient radiation, waiting times and hospital costs.

FUNDING

This work was supported by a scholarship from the University of Otago, Wellington, New Zealand and a grant from the Surgical Research Trust in combination with philanthropists. Both sponsors had no role in the study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

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