The economic implications of unsuspected findings from CT urography performed for haematuria

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Objectives: We set out to determine the prevalence of unsuspected findings from CT urography (CTU) performed for haematuria and to evaluate the economic implications associated with the subsequent management of these findings.

Methods: We analysed the results of 778 consecutive CTU scans performed in a haematuria clinic between 2008 and 2010. We excluded cases where diagnosis of an abnormality had been made prior to CTU. Costs incurred during the follow-up of unsuspected findings were calculated following guidance set out in the NHS Costing Manual 2009/10.

Results: 778 CTU scans were performed for patients attending a haematuria clinic from 2008 to 2010. 455 men and 323 women underwent CTU scan; they had a median age of 62 years. 56% of scans were found to have unexpected extra-urinary findings (587 abnormalities in 439 scans). Common findings included diverticular disease (138, 17.7%), adrenal masses [85, 10.9%; 40 (5.1%) of which were indeterminate], lung abnormalities (67, 8.6%), gall bladders containing calculi (44, 5.7%), adnexal cysts (25, 7.7% of women) and aortic aneurysms (18, 2.3%). These findings led to a total of 136 outpatient appointments, 88 radiological investigations and 11 procedures (4 of which were major). The overall cost incurred was £47 366, or £60 per patient.

Conclusion: CTU is associated with a high rate of unsuspected findings. There is an economic implication to performing CT scanning in this setting, in which further unanticipated investigation and treatment cost is approximately £60 per patient.

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The use of CT urography (CTU) in the investigation of haematuria is increasing. Previously, intravenous urography (IVU) was the primary imaging modality for the upper urinary tract. However, CTU has been shown to be more accurate at identifying upper tract urothelial pathology [1–3]. It also has the advantage of providing accurate staging for newly diagnosed tumours of the urinary tract and, in particular, may provide valuable staging information prior to an endoscopic resection in bladder cancer. CTU has become more widely accessible, with an increased number of CT scanners globally. Additionally, the high radiation dose associated with CTU has been significantly reduced with the newer double and triple bolus techniques [4, 5]. When CTU is performed as the primary imaging modality in haematuria, it reduces the number of patients who undergo CTU following an inadequate IVU.

There is, however, a significant economic implication to the use of CTU in such a common condition. This lies in part with the scans themselves, but also in the incidental extra-urinary findings from these scans. Other studies have evaluated the costs of incidental findings in CT colonography or coronary CT [6–8] and have demonstrated a significant economic burden in the follow-up and investigation of these patients. The vast majority of incidental findings do not need definitive

treatment, so the costs cannot be completely balanced by the early identification of treatable disease.

We set out to evaluate the prevalence of unsuspected extra-urinary findings from CTU scans performed for haematuria and determine the subsequent economic implications associated with these findings.

Methods and materials

We performed a retrospective analysis of 778 consecutive CTU scans from a protocol haematuria clinic in the Salford Royal Foundation Trust, Salford, UK, between 2008 and 2010. Patients aged over 40 years with either visible or non-visible haematuria underwent CTU and flexible cystoscopy unless contraindicated by either renal impairment or contrast allergy or where there was a poor performance status, meaning that investigation would not change management. If CT was contraindicated, an ultrasound of the urinary tract was performed (as a minimum). For those patients under the age of 40 years, flexible cystoscopy and ultrasound were performed for cases of non-visible haematuria. For these patients, CTU was used in cases of visible haematuria unless there was evidence of a benign diagnosis such as a stone or a urinary tract infection. The CT scanner used was a multidetector GE VCT 64 slice (GE Healthcare, Little Chalfont, UK), and a double bolus technique was employed to allow visualisation of the renal parenchyma and excretory phase in one scan, as described previously [5].

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We recorded all findings reported on the CTU scans and used patient records to determine what subsequent investigation, follow-up and treatment were instigated. If the abnormality had been known of prior to the CTU scan, this was excluded from the cost analysis. Significant incidental findings were defined as any finding that incurred follow-up. Further patient interventions, including investigations, appointments and treatment, were priced using the NHS Reference Costs Manual for 2009/10 [9]. Inpatient costs were calculated using healthcare resource groups (HRGs). If any patient exceeded the expected length of stay for a particular HRG, we included the costs for these additional days, per the methodology in the NHS Costing Manual 2009/10 [9]. We used the overall cost to derive a cost per patient associated with the incidental findings from CTU scans in the investigation of haematuria.

Results

778 CTU scans were performed for patients attending a haematuria clinic from 2008 to 2010. 454 men and 324 women underwent CTU; their ages ranged from 18 to 93 years (median, 62 years). The majority of referrals were via general practice (79%), with 27% via an urgent suspected cancer referral. Of the remaining 21%, 14% were from another hospital-based speciality, 4% were via the urology ward and 3% were from the emergency department. There were 398 patients with visible haematuria, 373 with non-visible haematuria and 7 in whom there was no clear documentation. 320 patients complained of new lower urinary tract symptoms in association with haematuria, 440 were asymptomatic and 18 had no documentation of urinary symptoms.

In total, there were 587 unsuspected extra-urinary findings in 438 scans, accounting for 56% of all scans performed: 287 scans exhibited 1 incidental finding, 116 exhibited 2 findings and 35 had >3 findings. Common findings included diverticular disease (138, 17.7%), adrenal masses [85, 10.9%; 40 (5.1%) of which were indeterminate], lung abnormalities (67, 8.6%), gall bladders containing calculi (44, 5.7%), adnexal cysts (25, 7.7% of women), benign liver abnormalities such as haemangiomas (20, 2.6%) and aortic aneurysms (18, 2.3%) (Table 1). After excluding findings that were deemed clinically insignificant at the time of scanning, such as diverticular disease or benign lung abnormalities requiring no further follow-up, or those that were already known, there were 193 clinically significant findings in 114 scans (15% of all scans performed).

Suspicious urological abnormalities were found in 176 scans: 127 (16.3%) bladder, 15 (1.9%) upper tract urothelial and 34 (4.4%) renal. These were subsequently diagnosed as malignancies in 51 of the 127 (40.1%) bladder lesions, 8 of the 15 (5.3%) upper tract urothelial abnormalities and 17 of the 34 (50%) renal abnormalities. There were a further 12 bladder malignancies identified on cystoscopy that were not seen on CT. There were no upper tract tumours identified subsequently following normal CT scans, and none in patients under the age of 50 years. There were also 7 (0.9%) patients diagnosed with bladder stones, 31 (4.0%) with ureteric stones and 101 (13.0%) with renal calculi.

Table 1. Extra-urinary findings from CT scans performed in the investigation of haematuria

Finding	n (%)
Diverticular disease	138 (17.7)
Adrenal masses	85 (10.9)
Indeterminate adrenal masses	40 (5.1)
Lung abnormalities	67 (8.6)
Gall stones	44 (5.7)
Adnexal cysts	25 (7.7)
Benign liver abnormality	20 (2.6)
Aortic aneurysms	18 (2.3)

There were a total of 136 outpatient appointments, including 55 new patient and 81 follow-up appointments. There were 88 radiological investigations, 54 CT scans, 20 MRI scans, 13 ultrasound scans and 1 nuclear medicine bone scan, as shown in Table 2. The CT scans that were subsequently performed were interval scans to re-assess abnormalities. A total of 11 procedures followed from the incidental findings, including 2 endoscopic retrograde cholangiopancreatographies, 1 oesophagoduodenoscopy, 2 fiberoptic bronchoscopies and 2 hysteroscopies. There was a total of four major surgical procedures, an endovascular repair of an abdominal aortic aneurysm, a laparoscopic adrenalectomy, a laparoscopic cholecystectomy and an open oophorectomy.

The individual costings are shown in Table 2. Total radiology costs were £15 999, outpatient appointments were £16 579 and surgical procedures were £14 168. The overall cost incurred was £47 406, or £60 per patient. The cost of follow-up of incidental findings that culminated in no intervention was £34 784; this was compared with the cost incurred where intervention was necessary, which was £12 622.

Discussion

The use of CTU in haematuria is increasing as the availability of CT scanners improves and the radiation dose is minimised using techniques such as double or triple bolus contrast administration [4, 5]. The impact of incidental findings is therefore increasing, and this study has identified the cost implication associated with this. The rate of incidental findings was 56%, although many of these could be considered clinically insignificant at the time of scanning, such as diverticular disease or benign adrenal nodules. However, after excluding these "insignificant" findings, 15% of patients still had a clinically significant finding. The population studied included many elderly, unfit patients, so no further action was required for many of these findings. Nevertheless, despite this, there were still 88 radiological investigations.

Similar studies have been undertaken for different specialities such as CT colonography or cardiac CT [6–8]. One study by Xiong et al [7] identified 52% of scans as having clinically significant incidental findings from CT examinations. This result is similar to those found in our study, although the cost incurred from the incidental findings was £150 per patient, as opposed to the £60 per patient derived from our results. This difference may be

Table 2. The investigations, appointments and procedures performed based on incidental findings, with the respective cost

Investigation/procedure		n	Cost (£)
Radiology	Ultrasound abdomen	7	595
	Ultrasound pelvis	6	330
	CT chest with contrast	4	588
	CT abdomen/pelvis with contrast	47	7191
	MRI abdomen/pelvis	18	4932
	MRCP	2	468
	Bone scan	1	181
	CT-guided biopsy	3	1635
Urine/blood tests	Serology	37	64
	Urine tests	21	55
Outpatient/inpatient events	Outpatient appointments	136	16579
	Inpatient stay (in addition to procedure costing)	3	501
Surgical procedures	ERCP	2	1710
	OGD	1	406
	Hysteroscopy	2	1722
	Bronchoscopy	2	988
	Endovascular repair of AAA	1	1886
	Laparoscopic adrenalectomy	1	3436
	Laparoscopic cholecystectomy	1	1365
	Open oophorectomy	1	2675

AAA, abdominal aortic aneurysm; ERCP, endoscopic retrograde cholangiopancreatography; MRCP, MR cholangiopancreatography; OGD, oesophagogastroduodenoscopy.

a result of the different populations studied—the median age of our patients was lower: 62 years compared with 74 years in the Xiong et al study. This is supported by the results of Pickhardt et al [6], who identified incidental findings of “at least moderate potential clinical importance” in 8.6% of scans in patients with a lower mean age of 58 years, compared with 15% of scans in our study with incidental findings that were deemed clinically significant. It is possible that, with an aging population and a higher median age of patients undergoing haematuria investigations, our calculated costs will increase with time.

Haematuria is a common urological condition, which affects 5–20% of the population [10]; therefore, the economic implications of these incidental findings should not be underestimated, particularly in the unlikely event of screening programmes using urinalysis. At present, these hidden costs are not taken into account by organisations that undertake haematuria investigation, and we believe that our results may be useful to units considering a change to investigation protocols. Of note, the majority of costs incurred were in investigating findings that subsequently required no intervention. Therefore, given that the vast majority of incidental findings are not related to serious pathology, ultrasound and IVU could be used in preference to CT scanning and, in doing so, reduce subsequent unnecessary investigation and treatment. It is difficult, however, to quantify the cost of the early identification of a treatable asymptomatic condition such as an aneurysm or adrenal malignancy. The cost incurred per patient is also relatively low when compared with the CT urogram itself and it is unlikely that the use of CTU will decrease owing to its superiority over IVU in detecting upper tract urothelial pathology [1–3].

Our study is limited by the retrospective nature of the work. There were also many findings that were not followed up owing to patient co-morbidity or patient choice. Additionally, the decision to follow up an

incidental finding was based on an individual’s clinical judgement, which may have varied considerably. There were also no comprehensive guidelines as to the investigation of some of the incidental findings, particularly the adrenal masses. Many of these were certainly benign, yet the cost of several follow-up CT scans, together with the radiation exposure, cannot be underestimated. Although some studies have reported on the outcomes of incidental adrenal nodules in an effort to produce guidance for investigation [11–13], there still appears to be a tendency to overinvestigate these lesions for the small percentage that are clinically significant. More research into which lesions require further evaluation may help to rationalise resources.

There are further costs that have not been included in this study, such as those incurred by appointments and investigations by the general practitioner, or contact with supporting services such as specialist nurses, so the calculated cost per patient is a minimum estimate. It is difficult to assess whether the cost of £60 per patient is an acceptable cost for the use of CTU in haematuria. Some guidelines suggest CTU for visible haematuria and not for non-visible haematuria unless there is high suspicion from baseline investigations [14], and this may be an appropriate economic practice. However, there will be a small number of urothelial lesions missed by this approach, given that CTU has a diagnostic superiority to the alternative investigations for haematuria [1, 2]. Our diagnostic yield of urological malignancy was similar to that of previous studies [15, 16], although these used intravenous urography and not CT. It could be suggested that CTU be omitted in patients under the age of 50 years, given that we did not identify any urothelial malignancies in this group. However, it is likely that the use of CTU in the investigation of haematuria will only increase, and it is important to evaluate the economic implications associated with this trend.

We have demonstrated a high incidence of incidental findings identified on CTU performed as part of

haematuria investigations. The cost of the subsequent follow-up and management was calculated as £60 per patient. There is a significant economic implication of this finding, given that haematuria is a commonly investigated condition, and further research may help to determine which incidental findings require further evaluation.

References

1. Wang LJ, Wong YC, Huang CC, Wu CH, Hung SC, Chen HW. Multidetector computerized tomography urography is more accurate than excretory urography for diagnosing transitional cell carcinoma of the upper urinary tract in adults with haematuria. *J Urol* 2010;183:48–55.
2. Cowan NC, Turney BW, Taylor NJ, McCarthy CL, Crew JP. Multidetector computed tomography urography for diagnosing upper urinary tract urothelial tumour. *BJU Int* 2007;99:1363–70.
3. Albani JM, Ciaschini MW, Streem SB, Herts BR, Angermeier KW. The role of computerized tomographic urography in the initial evaluation of haematuria. *J Urol* 2007;177:644–8.
4. Kekelidze M, Dwarkasing RS, Dijkshoorn ML, Sikorska K, Verhagen PC, Krestin GP. Kidney and urinary tract imaging: triple-bolus multidetector CT urography as a one-stop shop—protocol design, opacification, and image quality analysis. *Radiology* 2010;255:508–16.
5. Chow LC, Kwan SW, Olcott EW, Sommer G. Split-bolus MDCT urography with synchronous nephrographic and excretory phase enhancement. *AJR Am J Roentgenol* 2007;189:314–22.
6. Pickhardt PJ, Hanson ME, Vanness DJ, Lo JY, Kim DH, Taylor AJ, et al. Unsuspected extracolonic findings at screening CT colonography: clinical and economic impact. *Radiology* 2008;249:151–9.
7. Xiong T, McEvoy K, Morton DG, Halligan S, Lilford RJ. Resources and costs associated with incidental extracolonic findings from CT colonography: a study in a symptomatic population. *Br J Radiol* 2006;79:948–61.
8. Lee CI, Tsai EB, Sigal BM, Plevritis SK, Garber AM, Rubin GD. Incidental extracardiac findings at coronary CT: clinical and economic impact. *AJR Am J Roentgenol* 2010;194:1531–8.
9. dh.gov.uk [homepage on the internet]. London, UK: Department of Health, 2010. Available from: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_112590
10. Britton JP, Dowell AC, Whelan P, Harris CM. A community study of bladder cancer screening by the detection of occult urinary bleeding. *J Urol* 1992;148:788–90.
11. Bernini GP, Miccoli P, Moretti A, Vivaldi MS, Iaconi P, Salvetti A. Sixty adrenal masses of large dimensions: hormonal and morphologic evaluation. *Urology* 1998;51:920–5.
12. Lumachi F, Borsato S, Tregnaghi A, Basso SM, Marchesi P, Ciarleglio F, et al. CT-scan, MRI and image-guided FNA cytology of incidental adrenal masses. *Eur J Surg Oncol* 2003;29:689–92.
13. NIH state-of-the-science statement on management of the clinically inapparent adrenal mass (“incidentaloma”). *NIH Consens State Sci Statements* 2002;19:1–25.
14. Rodgers M, Nixon J, Hempel S, Aho T, Kelly J, Neal D, et al. Diagnostic tests and algorithms used in the investigation of haematuria: systematic reviews and economic evaluation. *Health Technol Assess* 2006;10:iii–iv, xi–259.
15. Khadra MH, Pickard RS, Charlton M, Powell PH, Neal DE. A prospective analysis of 1,930 patients with hematuria to evaluate current diagnostic practice. *J Urol* 2000;163:524.
16. Edwards TJ, Dickinson AJ, Natale S, Gosling J, McGrath JS. A prospective analysis of the diagnostic yield resulting from the attendance of 4020 patients at a protocol-driven haematuria clinic. *BJU Int* 2006;97:301.