Received:
14 December 2014

Revised:
25 November 2015

Accepted:
2 December 2015

doi: 10.1259/bjr.20140847

Cite this article as:

Schramm D, Jasaabuu C, Bach AG, Tennstedt O, Spielmann RP, Surov A. Costs associated with evaluation of incidental breast lesions identified on computed tomography. *Br J Radiol* 2016; **89**: 20140847.

FULL PAPER

Costs associated with evaluation of incidental breast lesions identified on computed tomography

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Objective: The purpose of this study was to calculate the costs associated with the evaluation of breast incidentalomas (BI) identified on CT.

Methods: All CT scans of the thorax performed at the radiological department of the University Hospital of the Martin-Luther-University Halle-Wittenberg between the years 2006 and 2014 were reanalysed retrospectively. 111 patients with BI were identified. The radiological and clinical reports of these cases were examined, and the costs of all further diagnostic procedures performed to clarify the detected BI were calculated.

Results: In 31 (27.9%) of the 111 patients, BI were not further investigated. Of the remaining 80 (72.1%) cases of BI, primary breast carcinoma was diagnosed in 10 (12.5%) cases, breast involvement by lymphoma in 7 (8.8%) cases, intramammary metastases in 19 (23.7%) cases and

different benign findings in 44 (55.0%) cases. The total costs associated with clarification of BI in our institution ($n = 53$) amounted to €14,045.71. The costs per BI were €265.01 and per newly identified breast cancer €1560.63.

Conclusion: Breast lesions incidentally detected on CT should be categorized as major incidental findings because of the high frequency of malignancy. The radiologist should carefully evaluate the breast on CT images and all identified BI should be clarified. The clarification of BI is associated with a low economic burden in comparison with screening programmes for primary breast cancer.

Advances in knowledge: The radiologist should carefully evaluate the breast on CT and all identified BI should be clarified. The evaluation of BI is associated with a low economic burden.

INTRODUCTION

The use of CT increased in recent years for a variety of diagnostic pathways.^{1,2} For example, Broder and Warshawer² analysed the number of CT investigations in their adult emergency department during 2000–2005. The authors found that head CT increased by 51%, cervical spine CT by 463%, chest CT by 226%, abdominal CT by 72% and miscellaneous CT by 132%. This resulted in the rise of incidental findings (IF), *i.e.* findings that were not related to the scope of the ordered investigation.^{1–4} In addition, IF induced further investigations for diagnosis and follow-up with consequent economic and emotional costs. The most frequent IF were thyroid and adrenal gland incidentalomas.^{1,3} Breast incidentalomas (BI) have also been described in the literature.^{5–11}

As reported previously, BI are relatively rare with a frequency ranging from 0.05% to 1.3%.^{5–10} According to the literature,^{6,7} most BI are malignant. Furthermore, as mentioned previously, reliable differentiation between

malignant and benign breast lesions on thoracic CT is impossible.¹⁰ Therefore, BI identified on CT have to be evaluated by further radiological and, if necessary, histological means.^{7,10} However, the evaluation of BI may result in high additional costs. There were several reports studying the economic burden of IF detected on CT.^{12–15} For example, Liu et al analysed the impact of imaging costs of IF identified on CT urography.¹⁴ The authors found that the additional costs were \$438.39 per patient including follow-up imaging.¹⁴ In another investigation, Xiong et al¹⁵ studied the costs associated with extracolonic IF detected on CT colonography. According to their study, the added costs were £153 per patient owing to the detected IF—more than the costs of the CT colonography itself.¹⁵

The economic impact of the evaluation of BI has not been analysed previously. Therefore, the purpose of this study was to calculate the additional costs associated with the evaluation of BI identified on CT.

METHODS AND MATERIALS

This study was approved by the institutional review board. All CT scans of the thorax performed at the radiological department of the University Hospital of the Martin-Luther University of Halle-Wittenberg between the years 2006 and 2014 were reanalysed retrospectively. Using the electronic picture archive (Centricity™ PACS; GE Medical Systems, Milwaukee, WI) of the hospital, the images of 14,428 patients together with the radiological report were reviewed at a workstation by three radiologists (AS, CJ and DS) with 12, 8, and 7 years' experience of general radiology, respectively.

Different CT protocols were used depending on the clinical questions. Only CT scans after intravenous application of contrast medium were included in the analysis. The analysis identified all breast masses which exhibited hyperdensity relative to the surrounding breast parenchyma. Intramammary calcifications without breast mass were excluded. Patients with known breast cancer or direct tumour invasion from the chest wall were also excluded from the study. The remaining hyperdense lesions were classified as BI.

Overall, 111 patients with contrast-enhancing intramammary breast lesions were identified. There were 109 females and 2 males, with a mean age of 62.23 ± 12.81 years.

Furthermore, the radiological and clinical reports of the 111 cases were evaluated to check if the BI were mentioned in the report, and if so, to assess the cost of all further diagnostic investigations undertaken to clarify the detected BI. The costs of all further diagnostic investigations to clarify the detected intramammary incidentalomas were calculated according to the institutional accounting tables corresponding to the year of investigation.

For statistical analysis, the SPSS statistical software package (SPSS® v. 17.0; IBM Corp., New York, NY; formerly SPSS Inc., Chicago, IL) was used. Collected data were evaluated by means of descriptive statistics (absolute and relative frequencies). Categorical variables were expressed as percentages.

RESULTS

The frequency of BI was 0.77%. In 31 (27.9%) of the 111 patients, the retrospectively identified BI were not evaluated by specific breast investigations such as mammography or breast ultrasound (Figure 1). In 14 (12.6%) patients, the lesions were described as probably benign because of their unchanged appearance on CT within 1–2 years ($n = 6$) or as metastatic lesions in patients with end-stage malignancies ($n = 8$). In 10 (9.0%) patients, the radiologists recommended further evaluation of the detected breast masses; however, the recommendations were not followed by attending physicians. BI were not reported at the time of the CT investigation in two (1.8%) cases. One (0.9%) patient died shortly after the CT investigation. Finally, four (4%) old patients declined further evaluation of the identified breast lesions (Figure 1).

In 80 (72.1%) patients, BI were evaluated by further investigations (Figure 1). In most cases ($n = 53$), the identified BI were clarified in our institution, and in 27 patients, BI were examined in external institutions. Malignant lesions were diagnosed in 36 (45% of 80) patients. In detail, primary breast carcinoma was diagnosed in 10 (12.5%) cases, breast involvement by lymphoma in 7 (8.8%) cases, intramammary metastases from solid tumours in 19 (23.7%) cases and different benign findings in 44 (55.0%) cases (Figures 2–4).

The mean age of the patients with benign lesions was 59.2 ± 14.2 years, range 31–85 years, and the mean age of the patients

Figure 1. Identified breast incidentalomas (BI) and their different clinical scenarios.

Figure 2. (a) Incidentaloma in the breast (arrow) on CT. The lesion was described by the radiologist and a further evaluation was recommended. (b) Mammography identified a lesion suspicious of malignancy. Histological examination after mammographic-guided biopsy revealed an invasive ductal carcinoma.

with breast cancer was 62.5 ± 11.4 years, range 43–82 years ($p = 0.10$).

The total costs associated with clarification of BI in our institution accounted to €14,045.71. The costs per BI were €265.01 and per case with malignant BI €610.68. In addition, the costs per newly identified breast cancer were €1,560.63.

DISCUSSION

Our analysis showed that three different scenarios regarding breast lesions incidentally detected on CT were encountered. Firstly, BI were described by radiologists and evaluated by further examination. Secondly, BI were identified and a further examination was recommended; however, the radiological statement was ignored. Thirdly, the breast lesions were not described/detected by the radiologists. A similar constellation was reported previously for thyroid incidental findings.¹⁶ For instance, the original radiological reports described thyroid incidentalomas in 6% of the investigated patients.¹⁶ However,

a retrospective analysis identified thyroid lesions in further 9.5% of the cases.¹⁶

According to the literature, the identified incidental findings can be categorized as follows: major or clinically relevant, moderate or possibly clinically relevant and minor or clinically not relevant.¹ Typical major IF include arterial vessel aneurysms, solid hepatic, renal or pancreatic masses and pulmonary embolism.¹ Moderate IF comprise vessel ectasia, thyroid incidentaloma, gallstone and prostate enlargement.¹ Finally, minor IF are splenic, renal or hepatic cysts, calcified pulmonary nodules and degenerative changes of the spine.¹

Breast lesions were classified as moderate IF.¹ However, as reported previously, most intramammary nodules were malignant.^{7,10} For example, a systematic review regarding BI detected on CT showed that approximately 49% of all reported BI represented malignant lesions, range 28.2–69.6%.⁷ In addition, the frequency of primary breast carcinoma varied from

Figure 3. (a) CT documenting a breast incidentaloma (arrow). (b) Mammography of the affected breast showing the lesion (arrows). (c). Ultrasound of the detected breast mass. Histological investigations of the lesions after ultrasound-guided biopsy revealed a metastasis of malignant melanoma.

Figure 4. Identified breast incidentaloma (arrow). Mammography and ultrasound (not shown) revealed a fibroadenoma.

9.2% to 60.9%.⁷ In the present study, 45% of the clarified BI were malignant. Therefore, we think that breast findings should be correctly classified as major IF. As mentioned previously, there were no differences between benign lesions and breast cancer regarding their CT morphological features on thoracic CT.¹⁰ Therefore, all breast lesions should be clarified by further examinations.

Moyle et al⁵ reported that patients with malignant BI were statistically significantly older in comparison with patients with benign BI. In our analysis, there were no significant age differences between patients with malignant and benign BI. In another studies about incidental intramammary findings, no

information regarding age of patients with malignant or benign BI was given.⁷

According to previous reports, the critical question concerning incidental findings is not only whether they should be reported but also what their effect is clinically and economically.¹

Our analysis showed that the costs associated with clarification of the identified breast lesions were €14,045.71. In addition, the costs per newly identified breast cancer were €1,560.63. According to the literature, the costs of detection of breast cancer in different screening programmes varied from \$3665 to \$122,598 per cancer case.^{17–19} Therefore, the evaluation of the BI and diagnosis of breast carcinoma in our analysis was associated with significantly lower costs in comparison with screening programmes.

Our study had several limitations. Because of its retrospective nature, not every BI could be clarified. Also, we analysed only immediate costs regarding radiological/histopathological clarification of breast lesions but not the costs of therapy of the BI. In addition, the costs were calculated according to the institutional accounting tables, and accounting methods may be different in several institutions.

In conclusion, breast lesions incidentally detected on CT should be categorized as major IF because of the high frequency of malignancy. The radiologist should carefully evaluate the breast on CT images, and all identified BI should be clarified. The clarification of BI is associated with a low economic burden in comparison with screening programmes for identification of primary breast cancer.

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