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Cost implications of unwarranted imaging for distant metastasis in women with early-stage breast cancer in Ontario

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ABSTRACT

Introduction Despite the publication of multiple evidence-based guidelines recommending against routine imaging for distant metastasis in patients with early-stage (I/II) breast cancer, such imaging is frequently performed. The present retrospective cohort study was conducted to estimate the cost of unnecessary imaging tests in women with stage I and II breast cancer diagnosed between 1 January 2007 and 31 December 2012 in Ontario.

Methods We obtained patient-level demographic and tumour data from a large provincial dataset. The total cost of unwarranted imaging tests (in 2015 Canadian dollars) was considered to be equal to the sum of imaging costs incurred between 2007 and 2012 and was stratified by disease stage, imaging modality, and body site.

Results Of the 26,547 identified patients with early-stage breast cancer, 22,811 (85.9%) underwent at least 1 imaging test, with an average of 3.7 tests per patient (3.2 for stage I patients and 4.0 for stage II patients) over 5 years. At least 1 imaging test was performed in 79.6% of stage I and 92.7% of stage II patients. During a 5-year period, the cost of unwarranted imaging in patients with early-stage breast cancer ranged from CA$4,418,139 to CA$6,865,856, depending on guideline recommendations.

Conclusions Our study highlights the substantial cost of excess imaging that could be saved and re-allocated to patient care if evidence-based guidelines are followed. Future studies should assess strategies to ensure that evidence-based guidelines are followed and to increase awareness of the cost implications of nonadherence to guidelines.

Key Words Costs, unwarranted imaging for distant metastasis, early-stage breast cancer, Ontario

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INTRODUCTION

Breast cancer is the most common cancer in Canadian women, with an estimated 25,000 new cases annually[1–3]. A new diagnosis of breast cancer has considerable cost implications for both the patient and the health care system. In recent years, national (http://www.choosingwiselycanada.org) and international (http://www.choosingwisely.org) drives through the Choosing Wisely initiative have set out to ensure the most appropriate use of resources. In response to Choosing Wisely, the American Society of Clinical Oncology published its recommendations on best practices in oncology, advocating against the use of radiologic imaging for distant metastatic disease in asymptomatic patients with pathologic early-stage (I/II) breast cancer[4]. The American Society of Clinical Oncology based its recommendation in part on the low incidence of radiologically evident metastases in early-stage disease (0.2%–1.2%)[5].

In Canada, Cancer Care Ontario recommends against imaging for patients with stage I disease and bone scans for those with stage II disease[6]. Although imaging might offer little to no benefit and might be harmful, recent evidence nevertheless shows that most patients still undergo imaging for metastatic cancer regardless of their disease stage[7]. The objective of the present study was therefore to estimate and describe the cost of unwarranted imaging in women diagnosed with stage I or II breast cancer in Ontario.

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METHODS

We used provincial health administrative datasets housed at the Institute for Clinical Evaluative Sciences to conduct a retrospective population-based cohort study. Using the Ontario Cancer Registry, all women who were diagnosed with early-stage (I/II) breast cancer between 2007 and 2012 were identified. This Ontario Cancer Registry cohort was linked with the Discharge Abstract Database maintained by the Canadian Institute for Health Information to identify patients who underwent breast-related surgeries and with the Ontario Health Insurance Plan to identify all claims made by physicians (and other health care providers) for insured services provided to residents of Ontario. A detailed description of the study cohort has been published elsewhere[7].

To ascertain that only primary operable patients were included, our study population was restricted to patients with a first diagnosis of breast cancer who underwent surgery within 3 months of a tissue diagnosis date. Patients with an earlier breast cancer diagnosis or stage 0 (including ductal carcinoma *in situ*), III, IV, null, or unknown disease at the index year were excluded.

Imaging was identified in the Ontario Health Insurance Plan database through imaging fee codes and was classified by body site (skeleton; thorax; abdomen or pelvis, or both; other) and modality (bone scan, computed tomography, magnetic resonance imaging, ultrasonography, radiography, positron-emission tomography). Given that the pattern of imaging can depend on an imaging sequence, we also categorized imaging as initial or confirmatory. "Initial imaging" was defined as the first imaging test performed on a body site in the pre-specified time period. "Confirmatory imaging" was defined as the second imaging test performed on a body site that had already been imaged.

For the present study, we estimated the cost of unwarranted imaging under two scenarios. In the first scenario, we adopted the American Society of Clinical Oncology recommendation and defined an unwarranted imaging test as preoperative or postoperative imaging performed in asymptomatic women with pathologic stage I or II breast cancer. In the second scenario, we defined unwarranted imaging using the Cancer Care Ontario recommendation to forgo imaging for patients with stage I and II disease and bone scans for those with stage II disease.

The cost of unwarranted imaging was calculated by multiplying the frequency of each unwarranted imaging test by its unit cost, which included both the professional and the technical components, obtained from *Schedule of Benefits for Physician Services*[8] and the published literature[9]. The total cost of unwarranted imaging tests was equal to the sum of imaging costs incurred during 2007–2012 and was stratified by disease stage, modality, and body site. All costs are expressed in 2015 Canadian dollars. All analyses were performed using R software application (version 3.2.2 for Windows: The R Foundation, Vienna, Austria).

RESULTS

Of the 26,547 women diagnosed with early-stage breast cancer during 2007–2012 in Ontario, 13,724 (51.7%) had stage I and 12,823 (48.3%) had stage II disease. More than half the study cohort (54.2%) was diagnosed with breast cancer at the age of 60 years or older.

Approximately 85.9% of early-stage breast cancer patients received at least 1 imaging test. Of those patients, 10,921 (47.9%) had stage I and 11,882 (52.1%) stage II disease. Most of the tests (76.2%) were categorized as initial imaging. For the patients who underwent imaging, those with stage I disease received a mean of 3.2 ± 1.8 imaging tests, and those with stage II disease received a mean of 4 ± 1.9 imaging tests. In total, 83,249 imaging tests (overall mean: 3.6 ± 1.9 tests) were performed.

The anatomic areas most imaged (Figure 1) were the abdomen and pelvis (either or both: 34.5%), the thorax (33.5%), and the skeleton (29.0%). The three most common imaging modalities were radiography, ultrasonography, and bone scan. Figure 1(A) shows that the distribution of imaging tests by modality was similar for each disease stage. The proportion of imaging tests varied according to the sequence of imaging tests. The most common site for initial imaging was abdomen and pelvis (either or both: 37.1%), followed by thorax (32.2%) and skeleton (27.5%). The most common site for confirmatory imaging was the thorax (37.7%), followed by the skeleton (33.8%), and abdomen and pelvis (either or both: 26.2%).

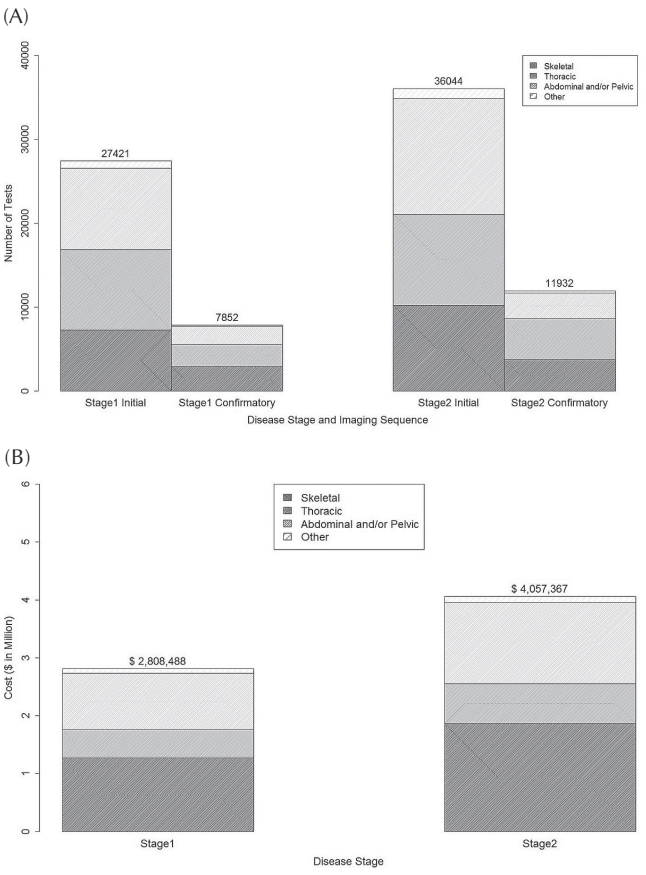

FIGURE 1 (A) Frequency of radiologic imaging for metastatic disease by disease stage and by imaging site and sequence, 2007–2012. (B) Total cost of radiologic imaging for metastatic disease by disease stage and imaging site, 2007–2012.

Table I shows the cost of imaging in patients who underwent at least 1 imaging during 2007–2012. The distribution of imaging cost varied by disease stage. Patients with stage II breast cancer incurred higher imaging costs than those with stage I breast cancer: CA$6,865,856 (CA$535.43 per capita) compared with CA$2,808,488 (CA$204.64 per capita). Isotopic bone scans represented the largest total imaging cost in patients with either stage I or stage II disease. For patients with stage I breast cancer, the costs of radiography (26.1%) and ultrasonography (21.7%) represented the second and third cost drivers respectively. For patients with stage II breast cancer, computed tomography was the second-largest cost driver (22.7%), followed by radiography (21.2%). Figure 1(B) shows that the cost of imaging tests also depended on the anatomic area imaged, with skeletal imaging proving to be the most expensive, followed by imaging of abdomen and pelvis and of thorax.

Based on the American Society of Clinical Oncology recommendation, 83,249 excess imaging procedures were performed, costing CA$6,865,856 for the 5-year period of interest. Similarly, according to the Cancer Care Ontario recommendation, 45,127 imaging tests were deemed unwarranted, costing CA$4,418,139.32 for the 5-year period (Table II).

TABLE I Unit cost and frequency of radiologic imaging for metastatic disease in asymptomatic patients with pathology-diagnosed early-stage breast cancer in Ontario

Site and type of imaging	Unit cost (CA$)	Breast cancer stage	Frequency	Total cost (CA$)
Skeletal				
Bone scan	163.35	I	6,252	1,021,264
		II	9,854	1,609,651
CT	75.85	I	204	15,473
		II	312	23,665
MRI	108.80	I	1,433	155,910
		II	1,378	149,926
Radiography	33.75	I	2,326	78,503
		II	2,421	81,709
Thoracic				
CT	86.60	I	1,407	121,846
		II	3,019	261,445
Radiography	33.75	I	10,765	363,319
		II	12,678	427,883
Abdominal or pelvic				
Ultrasonography	81.95	I	8,871	726,978
		II	10,668	874,243
MRI	73.35	I	228	16,724
		II	385	28,240
CT	86.48	I	2,723	235,485
		II	5,839	504,957
Other				
Ultrasonography	40.10	I	329	13,193
		II	447	17,925
MRI	91.08	I	219	19,945
		II	259	23,588
CT	82.98	I	435	36,095
		II	584	48,458
Radiography	33.75	I	76	2,565
		II	126	4,253
PET	237.50	I	5	1,188
		II	6	1,425

CT = computed tomography; MRI = magnetic resonance imaging; PET = positron-emission tomography.

DISCUSSION AND CONCLUSIONS

As health care costs continue to rise, attention has been paid to increasing the efficiency of health care delivery. Several initiatives, including the Choosing Wisely campaign and Choosing Wisely Canada, have focused on eliminating wasteful or unwarranted health care services that provide little or no health benefit to patients[4,5].

In previous studies[7,10], we observed excess imaging at the local and provincial level, and in the present study, we evaluated the cost implications of unwarranted imaging in a large cohort of all primary operable breast cancer patients in Ontario. Our study shows that the cost of excess imaging was substantial. Higher imaging costs in stage II patients could indicate that patients with increased disease severity had a worse prognosis and might have required more frequent pre- and postoperative assessment and follow-up. Our results are consistent with those of Mittmann *et al.*[11], who suggested that, compared with patients at other disease stages, patients with stage II breast cancer consumed the largest overall total health care cost—mainly because they had more frequent cancer clinic visits, more physician claims, and were hospitalizations.

Although radiography was the most common imaging modality, bone scans accounted for the largest cost component (CA$2,947,398), chiefly because of high frequency and the high unit cost of bone scintigraphy. The greater frequency of bone scans could be related to the fact that bone is the most common site of breast cancer recurrence[12]; however, fewer than 2% of asymptomatic patients with pathology-confirmed stage II disease will have radiologic evidence of overt bone metastases[5].

Our study does not take into account physician visits, follow-up tests, or referrals to specialists that might have resulted from medical imaging. If those costs were to be included, the cost of unwarranted imaging to the health care system would be much larger. It is possible that some imaging tests might have been ordered for purposes other than assessment for metastasis; however, we were not able to determine the intent of each imaging test.

In summary, this study highlights a large portion of health care costs that could be saved or reallocated if practice guidelines for medical imaging in patients with early-stage breast cancer were adhered to. Strategies aimed at patients[13,14] and physicians[10,15] should be implemented to promote adherence to practice guidelines.

TABLE II Cost of unwarranted imaging in a 5-year period, by disease stage and guideline recommendation

Breast cancer stage	Total excess cost (CA$) by published guideline	
	ASCO	CCO
I	2,808,488.42	2,808,488.42
II	4,057,367.22	1,609,650.90
TOTAL	6,865,855.63	4,418,139.32

ASCO = American Society of Clinical Oncology; CCO = Cancer Care Ontario.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood *Current Oncology*'s policy on disclosing conflicts of interest, and we declare that we have none.

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