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Surgical Mammography Reporting in a Limited Resource Environment

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Abstract

Background Lack of resources and dedicated breast radiology has forced professionals other than radiologists to read mammography. We report a series of surgeon-read mammography in a developing country.

Methods Data were collected prospectively form January 2003 to June 2008 for all mammography performed at a tertiary hospital. The data acquired were demographics, previous treatment for breast pathology, and indication for and outcome of mammography, including diagnostic procedures and their results. The results were benchmarked against standard performance indicators.

Results Of 8,743 mammograms performed, 1,468 were for palpable lumps; the cancer diagnosis rate was 640 per 1,000 investigations (for 885 of these reported as compatible with malignancy, the cancer diagnosis rate was 95%; for 183 reported as indeterminate 60%, for 400 reported as benign/no abnormality 4%). Of 4,998 cancer follow-up mammograms, the cancer diagnosis rate was 15 per 1,000. For 76 of these reported as compatible with malignancy, the cancer diagnosis rate was 67%, for 161 reported as indeterminate, the biopsy rate was 36%, and cancer diagnosis rates of biopsy was 41%. Of 75 cancers diagnosed, 26 were locally recurrent after breast conservation and 49 new contralateral primaries, 84% of these were stage 0–I. Of 2,001 mammograms performed for screening, the biopsy rate was 4.5% and the cancer diagnosis rate of biopsy was 27%; the overall cancer diagnosis rate was 11 per 1,000 examinations; 96% of these were stage 0–1.

Conclusions Dedicated breast surgeons are equally proficient at mammography interpretation as radiologists. In resource-restricted environments, nonavailability of dedicated breast radiologists should not preclude development of breast units.

Introduction

In developed countries, digital mammography is utilized mainly as a screening modality [1–4], interpreted by specialized breast radiologists and performed on a cancer aware population [5–7].

Health services in developing countries are burdened with financial constraints, personnel shortages, and patient overload [8–13]. In Africa, a lack of radiologists and educational resources, especially with respect to mammography, is well documented [14]. Consequently, few publications have researched clinical breast imaging on the African continent [15, 16].

These restrictions forced the senior authors (KB, JA), dedicated breast surgeons serving an indigent population in a severely resource-restricted environment, to report mammography at a tertiary institution.

We report one of the largest series of surgeon-read mammography. This series establishes benchmarks for similar environments and may assist in health care policy formulation and planning in similarly resource restricted environments.

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Patients and methods

All mammography performed between January 2003 to June 2008 at a tertiary teaching hospital (Tygerberg Hospital, Cape Town, South Africa) was entered prospectively into a commercially available database (MS Access, Microsoft Corporation, Redmond, WA, USA). Demographic data were recorded, such as patient age and gender, clinical data, such as hormone replacement therapy and its duration, previous treatment for breast pathology, and the indication and outcome of the examination. Indications were categorized as "mass" for patients presenting with a palpable lump, "follow-up" after completion of primary therapy for cancer, and "screening" if no lump could be palpated. Screening was only offered to women who were perceived to be at high risk of breast cancer due to a family history of breast cancer or other factors.

All mammography was performed by certified mammographers using film-screen technique and then batch read on a weekly basis by one of two senior surgeons (KB and JA).

All mammography was performed initially on a General Electric Senographe (GE Healthcare, Chalfont St. Giles, United Kingdom) and later on a Giotto 6000 mammography system (Internazionale Medico Scientifica, Bologna, Italy). Film used was Agfa Mamoray HDR film (Agfa Corporation, Ridgefield Park, NJ). Films were developed on an Agfa Classic EOS developer (Agfa Corporation). Standard craniocaudal and mediolateral oblique views were taken; additional views, such as "Cleopatra" views, spot compression and magnification views, and "valley" views, were taken as indicated. Due to resource restrictions as outlined above, breast ultrasound was not available during the study period on a routine basis but was used very selectively.

The outcome of the mammography was classified according to a modified BIRADS classification [17]: BIRADS 3 and 4 lesions were grouped as indeterminate and patients were called back for short-term follow-up imaging or tissue acquisition for definitive diagnosis. Patients with BIRADS 5 lesions had tissue acquisition. The method of further imaging and/or tissue acquisition, histology, clinical staging, and the use of neoadjuvant therapy were recorded.

Patients who did not return for further evaluation were contacted by surface mail to ensure compliance. If there was no response after a second attempt in contacting the patient, the patient was considered lost (defaulted).

The cancer diagnosis rate was defined as the number of true cancer cases (histological proven cancer) identified at mammography divided by the total number of examinations as per indication. The positive predictive value (PPV) was defined as the number of pathologically confirmed cancer cases divided by the sum of pathologically confirmed cancer cases and confirmed cases of benign pathology. Three separate PPV calculations were performed: PPV_1, probability of cancer after abnormal mammography interpretation; PPV_2, probability of cancer after recommendation for biopsy after abnormal mammography; and PPV_3, probability of cancer after biopsy after abnormal mammography.

Results

A total number of 8,743 mammograms were performed between January 2003 and June 2008. The mean age of patients was 57 (range, 20–96) years.

Of the 8,743 mammograms, 1,468 were performed for patients with palpable breast lumps, 4,998 for follow-up, and 2,001 for screening; 276 mammograms were performed for localization procedures, specimen imaging after localization biopsies, and postinduction therapy. These

Table 1 Summary of final diagnoses as per indication for mammography

Indication	*n*	Abnormal mammogram	%	Histopathology	*n*	%
Mass	1,468	1,068	73	Malignant	939	88
				Benign	104	10
				Defaulted[a]	25	2
Follow-up	4,998	237	5	Malignant	75	32
				Benign	126	53
				No further investigation	22	9
				Defaulted	14	6
Screening	2,001	178	9	Malignant	24	13.5
				Benign	116	65
				No further investigation	28	16
				Defaulted	10	5.5

[a] Defaulted: patients who did not return for tissue acquisition

mammograms are excluded from further evaluation (Tables 1, 2, 3, 4, 5, 6, and 7).

Discussion

Traditionally, infectious disease management is the main goal in developing countries and cancer is not seen as a threat. With better control of these infectious diseases [19, 20], cancer is becoming a problem as life expectancy increases. Breast cancer is becoming an important health problem in developing countries where incidence rates have been increasing by up to 5% annually [19, 21]. Well-resourced countries have implemented guidelines for the optimum management of patients with cancer. Resource-restricted countries attempting to implement similar guidelines have to cope with lack of infrastructure and trained personnel, poor access to facilities, and cultural and socioeconomic barriers [19–22].

To improve patient outcome in low-resource countries, the Breast Health Global Initiative provides guidelines for breast cancer management in these environments [19, 23].

Table 2 Summary of further investigations performed per mammography result and final outcome

Indication	*n*	Outcome	*n*	Further investigations	*n*		*n*	%
Mass	1,468	Compatible with malignancy	885	Histology	885	Malignant	845	95
						Benign	24	3
						Defaulted	16	2
		Indeterminate	183	Histology	156	Malignant	94	60
						Benign	60	39
						Defaulted	2	1
				Imaging	27	Malignant	0	0
						Benign	20	74
						Defaulted	7	26
		Benign/no abnormality	400	Histology	294	Malignant	17	6
						Benign	261	89
						Defaulted	16	5
				Unilateral mammogram[a]	106	Normal	106	100
Follow-up	4,998	Compatible with malignancy	76	Histology	76	Malignant	51	67
						Benign	22	29
						Default	3	4
		Indeterminate	161	Histology	58	Malignant	24	41
						Benign	28	48
						Defaulted	6	11
				Imaging	103	Malignant	0	0
						Benign	76	74
						No further investigation	22	21
						Defaulted	5	5
		Benign/no abnormality	4,761					
Screening	2,001	Compatible with malignancy	28	Histology	28	Malignant	15	54
						Benign	11	39
						Default	2	7
		Indeterminate	150	Histology	62	Malignant	9	15
						Benign	50	81
						Defaulted	3	4
				Imaging	88	Malignant	0	0
						Benign	55	63
						No further investigation	28	32
						Defaulted	5	5
		Benign/no abnormality	1,823					

[a] Unilateral mammograms were performed where patients had local advanced breast carcinoma not suitable for mammography or where patients had had recent surgery

Table 3 PPV and cancer diagnosis rate per indication

	Mass	Follow-up	Screening
Total	1,468	4,998	2,001
Abnormal mammogram	1,068	237	178
Histology malignant	939	75	24
PPV_1	90%	34%	14%
PPV_2	92%	60%	28%
PPV_3	92%	60%	28%
Cancer diagnosis rate	640 per 1,000	15 per 1,000	12 per 1,000

Table 4 Cancer diagnosis rate per age group

Age (years)	Histology malignant	
<40	110	13 per 1,000
40–65	598	68 per 1,000
>65	330	38 per 1,000
Total	1,038	119 per 1,000

Table 5 Positive predictive value (PPV_3) per age group for patients with a palpable lump

Age (years)	Histological carcinoma	PPV_3
<40	104 of 116	90%
40–65	562 of 627	90%
>65	273 of 280	97%

Table 6 Staging of cancers as per mammogram indication

Indication	Stage	*n*	%
Mass	I	39	6
$n = 654$[a]	IIA	134	20
	IIB	168	26
	IIIA	92	14
	IIIB	141	22
	IV	80	12
Indication			
Follow-up ($n = 75$)	New contralateral primary[b]	49 (63%)	
	Local recurrence after breast conservation	26 (37%)	
Indication	Stage	*n*	%
Screening ($n = 24$)	0	18	75
	I	5	21
	II	1	4

[a] 285 of 939 records of patients with masses were unavailable for clinical staging

[b] 84% of new primaries were stage 0-I

Breast units need to evaluate their management with the goal of improving protocols for a better outcome in their specific environment. A control group, with similar environments, is needed to compare effectiveness. Mammography has been extensively audited and performance benchmarks have been published from various countries [24–30]. The largest data are from the Breast Cancer Surveillance Consortium-US (BCSC). Data of screening and diagnostic mammography are published and updated on the official website serving as a reference for performance benchmarks [31, 32].

The cancer diagnosis rate is one of the most important factors reflecting the quality of a mammography service [27, 31, 33–36]. Many factors influence the diagnosis rate, including age of the patient, indication for the investigation, and size of the tumor.

Dense breast tissue in the younger patient resulted in decreased sensitivity and diagnostic yield for mammography in some series [37–40] but has been disputed by others [38, 41]. In our series the sensitivity for patients younger than aged 40 years is 90%, which is similar to the older population group. In comparison, Wang et al. [42] (Taiwan) describe a sensitivity of 84% for patients younger than aged 40 years presenting with a palpable lump. Microcalcifications were detected in 40% of cases and were given as the reason for the high sensitivity because these are more easily detected in dense breasts. In the current series, patients presented with mostly advanced disease, which can explain the high sensitivity. Spiculated masses were described in more than 80% of cases.

The cancer diagnosis rate for patients presenting with a mass differs widely, which makes comparison difficult. Tuncbilek et al. [31] (Turkey) explained that their high values (86.4 per 1,000) can be due to late referral of patients with advanced disease and that they are a center for referral of patients with suspected breast cancer. Sickles et al. (USA) illustrated a cancer diagnosis rate of 49 per 1,000 for patients with palpable lumps. These patients present with small palpable lumps, average 20 mm [31, 36, 43]. The high value in the present series is explained as a result of that we serve as a referral center for patients with breast carcinoma and some referring institutions have the ability to make a pathologic diagnosis, thereby introducing a selection bias. The majority of our patients present with local advanced carcinoma; more than 74% present with at least stage 2b breast carcinoma. Reasons for late presentation can be attributed to the same factors that prevent implementation of developed world guidelines for breast cancer management [20–22].

Resource restrictions prevent us from implementing mammographic screening on a population level, therefore, we target a high-risk group of women. Comparatively, screening elsewhere is performed routinely on the general

Table 7 Histopathological staging per mammography indication

Indication	Tumor size (mm)	*n*	%	Lymph node infiltration	Neoadjuvant therapy
Mass (*n* = 330)[a]	0–19	76	23	53%	32%
	20–49	176	54	143 of 271[b]	208 of 654
	≥50	63	19		
	DCIS	15	4		
Follow-up (*n* = 26)[c]	0–19	18	69	27%	0
	20–49	3	12	3 of 11	
	≥50	0			
	DCIS	5	19		
Screening (*n* = 22)[d]	0–19	14	64	25%	0
	20–49	2	9	3 of 12	
	≥50	0			
	DCIS	6	27		

Age protocol: patients older than 70 years with early breast carcinoma are treated with lumpectomy or simple mastectomy and either adjuvant or neoadjuvant Tamoxifen only in a resource-restricted environment [18]

[a] 208 patients with masses had neoadjuvant therapy; 116 did not have surgery either due to defaulting treatment or progression of disease before surgery. These patients were not included in the histological staging

[b] 271 patients had regional surgical management; 59 were excluded from regional management with the aged protocol or due to advanced disease at time of surgery

[c] 26 of the 49 new contralateral breast carcinoma patients had surgical therapy and 23 defaulted surgery; 11 had regional management and 12 were excluded with the aged protocol

[d] 22 of 24 screening breast carcinoma patients had surgical management and only 12 had regional management with the age protocol

population [31, 32, 35, 44, 45]. This explains our higher diagnosis rate of 12 per 1,000 screening mammograms. We do not see this as a misallocation of resources. Detection of early breast carcinoma in the target population improves patient outcome and reduces the cost of management compared with patients who present with advanced disease [19, 22, 46].

There is a paucity of data on the results of mammography after an initial diagnosis of breast cancer. The American Society of Clinical Oncology recommends annual mammography in this setting [47]. Various series have shown that relapses occur more often in the first few years after treatment, recently the ATAC trial [48], and then decline steadily. Freedman and Montgomery report that the incidence of ipsilateral breast tumor recurrence declines with time, but the incidence of new contralateral carcinoma incidence increases with time, so that the total overall relapse rate in 15 years remains largely constant [49, 50]. Clinical follow-up does little to increase yield for detection of relapse, but mammography contributes significantly to early relapse detection. This holds true for new primary carcinomas as well as for local recurrences [50–52]. The current series follow-up mammography has a cancer detection rate of 15 per 1,000 (65% of which are new primary carcinomas). Montgomery et al. [50] (Edinburgh) reported that mammography detected 5.37 relapses per 1,000.

Two series have examined the proficiency of surgeons versus radiologists in mammography interpretation. Vidya and Dixon [53] found a nonsignificant difference in the sensitivity between surgeons and radiologists, but specificity and positive predictive values were identical. Rao et al. [54] showed that surgeons could read mammograms of symptomatic patients. Both series found a higher sensitivity of surgeons in the diagnosis of calcifications [53, 54]. In contrast to the present series, this may lead to a higher recall rate, but a low PPV_1.

In comparison, the PPV_{2+3} in the current series for patients with a palpable mass is greater than 90%, much higher than international benchmarks with mean value of 30.3 and 37.3% respectively [31, 35, 36, 55, 56]. This may be explained by the same factors contributing to a high cancer diagnosis rate and high number of advanced cancer cases.

In the current series, the PPV_1 for screening mammography was 14% and in the follow-up group 34%—both higher than international benchmarks of 5–10% for screening mammography [27, 31, 34, 57]. This is attributed to the fact that we perform selective screening and follow-up mammography for cancer patients, both with a higher incidence of cancer. The PPV_{2+3} for screening mammography is comparable with international benchmark values set by specialist radiologists ranging from 25–40% [24, 26, 27, 30, 45, 56, 57]. We were unable to find PPV_{2+3} values to compare to the current series follow-up mammography. Of note is that it is remarkably high with values greater than benchmarks set for patients with palpable lumps, illustrating the effective service.

The grouping of BIRADS® 3 and 4 lesions in a single "indeterminate" category was a pragmatic decision. Overlap between these categories, intra- and inter-observer variations in category assignment and variations in recommendation for further workup are well documented and have been the subject of reviews [58, 59]. In the clinical reporting setting, a decision on how to manage the patient is modified by the availability of previous imaging and clinical information. This—in our experience—often renders the differentiation between these categories and notably the further subdivision of BIRADS 4 lesions as proposed in the latest BIRADS classification often irrelevant.

Despite the performance reported here for a surgical team, we wish to emphasize that the two senior authors responsible for the mammography reading had extensive clinical experience gained in managing more than 400 new cases of breast cancer annually and attended internationally recognized courses in mammography interpretation before they embarked on the interpretation of mammography. Both typically read approximately 4,000 mammograms annually, and their performance is monitored on an ongoing basis. We suggest that colleagues who wish to embark on mammography reporting should do a similar effort.

Conclusions

Dedicated breast surgeons with an interest and specific training are equally proficient at mammography interpretation as radiologists. In resource-restricted environments, nonavailability of dedicated breast radiologists should not preclude the development of breast units.

References

1. Ishiyama M, Tsunoda-Shimizu H, Kikuchi M et al (2008) Comparison of reading time between screen-film mammography and soft-copied, full-field digital mammography. Breast Cancer 16:58–61
2. Kuzmiak CM, Pisano ED, Cole EB et al (2005) Comparison of full-field digital mammography to screen-film mammography with respect to contrast and spatial resolution in tissue equivalent breast phantoms. Med Phys 32(10):3144–3150
3. Morimoto T, Nagao T, Okazaki K et al (2008) Current status of breast cancer screening in the world. Breast Cancer 16:2–9
4. Seo BK, Pisano ED, Kuzmiak CM et al (2006) The positive predictive value for diagnosis of breast cancer full-field digital mammography versus film-screen mammography in the diagnostic mammographic population. Acad Radiol 13(10):1229–1235
5. Eaker S, Halmin M, Bellocco R et al (2008) Social differences in breast cancer survival in relation to patient management within a National Health Care System (Sweden). Int J Cancer 124:180–187
6. Halmin M, Bellocco R, Lagerlund M et al (2008) Long-term inequalities in breast cancer survival–a ten year follow-up study of patients managed within a National Health Care System (Sweden). Acta Oncol 47(2):216–224
7. Lagerlund M, Bellocco R, Karlsson P et al (2005) Socio-economic factors and breast cancer survival–a population-based cohort study (Sweden). Cancer Causes Control 16(4):419–430
8. Carlson RW, Anderson BO, Chopra R et al (2003) Treatment of breast cancer in countries with limited resources. Breast J 9(Suppl 2):S67–S74
9. Eniu A, Carlson RW, Aziz Z et al (2006) Breast cancer in limited-resource countries: treatment and allocation of resources. Breast J 12(Suppl 1):S38–S53
10. Kuehn BM (2007) Global shortage of health workers, brain drain stress developing countries. JAMA 298(16):1853–1855
11. Lehmann U, Dieleman M, Martineau T (2008) Staffing remote rural areas in middle- and low-income countries: a literature review of attraction and retention. BMC Health Serv Res 8:19
12. Ozgediz D, Jamison D, Cherian M et al (2008) The burden of surgical conditions and access to surgical care in low- and middle-income countries. Bull World Health Organ 86(8):646–647
13. Ozgediz D, Galukande M, Mabweijano J et al (2008) The neglect of the global surgical workforce: experience and evidence from Uganda. World J Surg 32(6):1208–1215
14. Rabinowitz DA, Pretorius ES (2005) Postgraduate radiology training in sub-Saharan Africa: a review of current educational resources. Acad Radiol 12(2):224–231
15. Edge J, Gudgeon A (2004) Screening for breast cancer. S Afr Med J 94(8):596–600
16. Reeler AV, Sikora K, Solomon B (2008) Overcoming challenges of cancer treatment programmes in developing countries: a sustainable breast cancer initiative in Ethiopia. Clin Oncol (R Coll Radiol) 20(2):191–198
17. American College of Radiology (2003) ACR breast imaging reporting and data system. American College of Radiology, Reston, VA
18. Wasserman LJ, Apffelstaedt JP, Odendaal JV (2007) Conservative management of breast cancer in the elderly in a developing country. World J Surg Oncol 5:108
19. Anderson BO, Shyyan R, Eniu A et al (2006) Breast cancer in limited-resource countries: an overview of the Breast Health Global Initiative 2005 guidelines. Breast J 12(Suppl 1):S3–S15
20. Sandelin K, Apffelstaedt JP, Abdullah H et al (2002) Breast Surgery International—breast cancer in developing countries. Scand J Surg 91(3):222–226
21. Smith RA, Caleffi M, Albert US et al (2006) Breast cancer in limited-resource countries: early detection and access to care. Breast J 12(Suppl 1):S16–S26
22. Anderson BO, Yip CH, Ramsey SD et al (2006) Breast cancer in limited-resource countries: health care systems and public policy. Breast J 12(Suppl 1):S54–S69
23. Anderson BO, Yip CH, Smith RA et al (2008) Guideline implementation for breast healthcare in low-income and middle-income countries: overview of the Breast Health Global Initiative Global Summit 2007. Cancer 113(8 Suppl):2221–2243
24. Dee KE, Sickles EA (2001) Medical audit of diagnostic mammography examinations: comparison with screening outcomes obtained concurrently. AJR Am J Roentgenol 176(3):729–733
25. Linver MN, Paster SB, Rosenberg RD et al (1992) Improvement in mammography interpretation skills in a community radiology practice after dedicated teaching courses: 2-year medical audit of 38, 633 cases. Radiology 184(1):39–43

26. Poplack SP, Tosteson AN, Grove MR et al (2000) Mammography in 53,803 women from the New Hampshire mammography network. Radiology 217(3):832–840
27. Robertson CL (1993) A private breast imaging practice: medical audit of 25,788 screening and 1,077 diagnostic examinations. Radiology 187(1):75–79
28. Sickles EA, Ominsky SH, Sollitto RA et al (1990) Medical audit of a rapid-throughput mammography screening practice: methodology and results of 27,114 examinations. Radiology 175(2):323–327
29. Sohlich RE, Sickles EA, Burnside ES et al (2002) Interpreting data from audits when screening and diagnostic mammography outcomes are combined. AJR Am J Roentgenol 178(3):681–686
30. Tabar L, Fagerberg G, Day NE et al (1992) The Swedish two-county trial of mammographic screening for breast cancer: recent results on mortality and tumor characteristics. Pathol Biol (Paris) 39(9):846
31. Tuncbilek I, Ozdemir A, Gultekin S et al (2007) Clinical outcome assessment in mammography: an audit of 7,506 screening and diagnostic mammography examinations. Diagn Interv Radiol 13(4):183–187
32. Ballard-Barbash R, Taplin SH, Yankaskas BC et al (1997) Breast Cancer Surveillance Consortium: a national mammography screening and outcomes database. AJR Am J Roentgenol 169(4):1001–1008
33. Spring DB, Kimbrell-Wilmot K (1987) Evaluating the success of mammography at the local level: how to conduct an audit of your practice. Radiol Clin North Am 25(5):983–992
34. Sickles EA (1992) Quality assurance. How to audit your own mammography practice. Radiol Clin North Am 30(1):265–275
35. Sickles EA, Wolverton DE, Dee KE (2002) Performance parameters for screening and diagnostic mammography: specialist and general radiologists. Radiology 224(3):861–869
36. Sickles EA, Miglioretti DL, Ballard-Barbash R et al (2005) Performance benchmarks for diagnostic mammography. Radiology 235(3):775–790
37. Houssami N, Irwig L, Simpson JM et al (2003) Sydney Breast Imaging Accuracy Study: comparative sensitivity and specificity of mammography and sonography in young women with symptoms. AJR Am J Roentgenol 180(4):935–940
38. Jeffries DO, Adler DD (1990) Mammographic detection of breast cancer in women under the age of 35. Invest Radiol 25(1):67–71
39. Johnstone PA, Moore EM, Carrillo R et al (2001) Yield of mammography in selected patients age ≤30 years. Cancer 91(6):1075–1078
40. Majid AS, de Paredes ES, Doherty RD et al (2003) Missed breast carcinoma: pitfalls and pearls. Radiographics 23(4):881–895
41. de Shaw PE, Marsteller LP, Eden BV (1990) Breast cancers in women 35 years of age and younger: mammographic findings. Radiology 177(1):117–119
42. Wang J, Chang KJ, Kuo WH et al (2007) Efficacy of mammographic evaluation of breast cancer in women less than 40 years of age: experience from a single medical center in Taiwan. J Formos Med Assoc 106(9):736–747
43. Bassett LW, Liu TH, Giuliano AE et al (1991) The prevalence of carcinoma in palpable vs. impalpable, mammographically detected lesions. AJR Am J Roentgenol 157(1):21–24
44. Bassett LW (1997) Determinants of quality in mammography. Surg Oncol Clin N Am 6(2):213–232
45. Perry N, Broeders M, de Wolf C et al (2008) European guidelines for quality assurance in breast cancer screening and diagnosis. Fourth edition—summary document. Ann Oncol 19(4):614–622
46. Anderson BO, Carlson RW (2007) Guidelines for improving breast health care in limited resource countries: the Breast Health Global Initiative. J Natl Compr Canc Netw 5(3):349–356
47. Khatcheressian JL, Wolff AC, Smith TJ et al (2006) American Society of Clinical Oncology 2006 update of the breast cancer follow-up and management guidelines in the adjuvant setting. J Clin Oncol 24(31):5091–5097
48. Howell A, Cuzick J, Baum M et al (2005) Results of the ATAC (Arimidex, Tamoxifen, alone or in combination) trial after completion of 5 years' adjuvant treatment for breast cancer. Lancet 365(9453):60–62
49. Freedman GM, Anderson PR, Hanlon AL et al (2005) Pattern of local recurrence after conservative surgery and whole-breast irradiation. Int J Radiat Oncol Biol Phys 61(5):1328–1336
50. Montgomery DA, Krupa K, Jack WJ et al (2007) Changing pattern of the detection of locoregional relapse in breast cancer: the Edinburgh experience. Br J Cancer 96(12):1802–1807
51. De Bock GH, Bonnema J, van der HJ et al (2004) Effectiveness of routine visits and routine tests in detecting isolated locoregional recurrences after treatment for early-stage invasive breast cancer: a meta-analysis and systematic review. J Clin Oncol 22(19):4010–4018
52. Montgomery DA, Krupa K, Cooke TG (2007) Follow-up in breast cancer: does routine clinical examination improve outcome? A systematic review of the literature. Br J Cancer 97(12):1632–1641
53. Vidya R, Dixon JM (2001) Should surgeons as well as radiologists report mammograms in symptomatic patients? Breast 10(2):140–142
54. Rao MC, Griffith CD, Griffiths AB (2001) Can breast surgeons read mammograms of symptomatic patients in the one-stop breast clinic? Ann R Coll Surg Engl 83(2):108–109
55. Feig SA (2007) Auditing and benchmarks in screening and diagnostic mammography. Radiol Clin North Am 45(5):791–800, vi
56. Rosenberg RD, Yankaskas BC, Abraham LA et al (2006) Performance benchmarks for screening mammography. Radiology 241(1):55–66
57. Rosen EL, Sickles E, Keating D (1999) Ability of mammography to reveal nonpalpable breast cancer in women with palpable breast masses. AJR Am J Roentgenol 172(2):309–312
58. Obenauer S, Hermann KP, Grabbe E (2005) Applications and literature review of the BI-RADS classification. Eur Radiol 15(5):1027–1036
59. Balleyguier C, Ayadi S, Van NK et al (2007) BIRADS classification in mammography. Eur J Radiol 61(2):192–194