INTRODUCTION

Recent years have seen a growing interest in quality of care as a means of improving medical care while controlling the rising costs of health services, practice variations, and inappropriate or useless interventions (1). The structure, process, and outcomes of care have all been the focus of investigation, using either implicit or explicit criteria (2, 3). Although outcomes are the ultimate end results by which the value of medical interventions can be assessed, they are also considered less sensitive and sometimes even irrelevant in this context (2, 3). This is certainly true with regard to breast cancer, where some major therapeutic innovations, such as the shift toward locoregional management with breast preservation, have not necessarily led to improvement in such an important outcome of treatment as survival (4).

In 1985, Donabedian (5) described the "epidemiology of quality" and the main predictors of optimal care among characteristics of the client, the attending physician, and the hospital of treatment. Using the same conceptual framework, the current review was undertaken to identify variables associated with the pattern of care offered to women with breast cancer, in an era where important therapeutic developments have taken place.

Our ultimate goal was to assess outputs as well as outcomes of treatment for breast cancer and their determinants and to promote evidence-based decision making in the organization of health services in breast cancer. This review should provide clues to be used by health planners and public health practitioners for breast cancer control, while also taking into account these patients' concerns and expectations. The abundance of the literature on health services in breast cancer and the uncertainty about the optimal treatment settings to be implemented both underscore the relevance of this critical appraisal.

Received for publication May 3, 1999, and accepted for publication May 5, 2000.

Abbreviations: CI, confidence interval; OR, odds ratio; RR, relative risk.
1 Direction de la Sante Publique, Regionale de la Sante et des Services Sociaux de Montral-Centre, Montral, Canada.
2 Groupe de Recherche en Epidemiole of University Laval and Centre des Maladies du Sein, Hopital du Saint-Sacrement, Quebec, Canada.
3 Centre de Recherche, Centre Hospitalier de Universite de Montreal, Hopitaux de l'Universite de Montreal, Canada.
Reprint requests to Dr. Nicole Hebert-Croteau, Direction de Sante Publique de Montral-Centre, Pavillon Lafontaine, 1301, rue Sherbrooke Est, Montral, PQ, H2L 1M3, Canada (e-mail: nrcroteau@santepub-mtl.qc.ca).

MATERIALS AND METHODS

Studies included in this review were identified by a computerized search of the MEDLINE database for the time period from 1985 to March 1999. The key words used were breast neoplasms, in combination with any of the following: audit, medical audit, hospitals, oncology service hospital, outcome and process assessment, mastectomy, radiotherapy, chemotherapy, hormonal therapy, combined modality therapy, treatment variation, quality of medical care, and quality of health care. In addition, reference lists of papers so identified were searched for additional publications on these topics.

We excluded self-reports of therapeutic activities obtained by surveys or hypothetical scenarios of case management. In addition, studies describing temporal or geographic variations without hypothesis testing about organizational features related to the provision of care, as well as ecologic analyses based on aggregated data without measurement on individuals, were excluded. Finally, economic evaluations (cost minimization, cost-effectiveness, cost-utility analyses, and so on) were not included. This review was restricted to papers published in either French or English. Studies corresponding to these criteria appear in references 6–67.

OVERVIEW OF PUBLISHED STUDIES ON QUALITY OF CARE IN BREAST CANCER

The majority of studies on the evaluation of the patterns of care for breast cancer were published in the 1990s, and publications on this topic were comparatively rare before this period. These evaluations were conducted on different study populations, including local/regional (8, 11, 13, 16, 17, 21–23, 25, 33, 34, 40, 42, 45, 49, 55, 58, 59, 61, 63–65) or national (6, 9, 12, 19, 29, 30, 38, 46, 47, 66) samples of breast cancer patients in the United States, as well as in Australia (14, 15, 27, 56, 57), Canada (31, 43, 51, 52, 67), Italy (7, 10, 24, 26, 32, 37, 39), Japan (28), Norway (50), South Africa (18), and the United Kingdom (20, 35, 36, 41, 44, 48, 53, 54, 60, 62). We therefore reviewed provision of care under several types of health systems.

The majority of studies evaluated the process of care (6–8, 10–14, 16, 17, 19–24, 27, 29–43, 45–55, 57–61, 64–67) and, less often, outcomes of treatment (9, 15, 18, 20, 25, 26, 28, 29, 33, 36, 40, 41, 44, 50, 55, 56, 60, 62, 63). In the first case, the focus was on locoregional management (7, 8, 11–14, 16, 19–24, 27, 29–43, 45–55, 57–61, 64–67), systemic adjuvant treatment (7, 8, 10, 16, 17, 20, 22, 23, 27, 29, 35, 36, 40, 41, 49, 50, 52–54, 59, 67), diagnostic procedures, such as stag-
Organizational Factors Related to Care for Breast Cancer

We did not include in this review demographic characteristics, such as age, race, or socioeconomic status, that might influence the treatment received but that do not truly refer to the organization of health services. These were taken into account as adjustment variables, but not for their main effect as predictors of care. Therefore, only insurance coverage or payment status was considered in this review. Several studies assessed the influence of this factor on either the process (8, 12, 14, 16, 29, 30, 33, 38, 40, 42, 45, 55, 57–59, 61, 64, 66) or outcomes (25, 29, 33, 40, 55) of treatment for breast cancer. Among these, six publications specifically compared quality of care between members of health maintenance organizations and individuals with a different type of insurance coverage (33, 40, 55, 58, 59, 66). Managed care refers to an organization of services that extends beyond the sole issue of funding. These reports were, however, summarized in this section but could as well have been included with the review of hospital variables associated with care received.

Several studies suggested that extensive insurance coverage is associated with more appropriate treatment for breast cancer (12, 29, 38, 42, 45, 64) and also with better survival (25). Some (12, 16, 25, 29) also evaluated the stage at presentation or specific diagnostic procedures and found a similar favorable influence of more coverage. In the largest study conducted on care for breast cancer, Johantgen et al. (38) used data from the Hospital Cost and Utilization Project to assess surgical treatment for breast cancer among 87,449 cases diagnosed in the United States between 1981 and 1987. Self-reported smokers had significantly less breast-conserving surgery (odds ratio (OR) = 0.78, 95 percent confidence interval (CI): 0.68, 0.89), adjusted for age, stage, race, comorbidity, hospital region, location, bed size, and teaching status. This finding has also been shown in other settings as well. Young et al. (42) looked at the cases of 9,288 women treated for breast cancer in Pennsylvania between 1986 and 1990 and found that those with private insurance were more likely to receive breast-conserving surgery (51.1 percent with Blue Cross or Blue Shield coverage vs. 43.6 percent with Medicaid and 36.9 percent with Medicare, p < 0.05) and also to subsequently have radiation therapy (79.9 percent, 60.0 percent, and 80.6 percent, respectively; p < 0.001). Two other studies also found greater proportions of breast-conserving surgery with more insurance coverage: the first one by Kotwall et al. (45) on 20,760 patients in 157 hospitals in North Carolina between 1988 and 1993 (OR of breast-conserving surgery with private insurance = 1.2, 95 percent CI: 1.0, 1.4, adjusted for age, residence, hospital caseload, and year of surgeon’s graduation) and the second one by Arnold et al. (64) on 238 cases admitted into a single teaching hospital in Jacksonville, Florida (40 percent breast-conserving surgery in funded patients vs. 29 percent in others, p = 0.04). A further investigation by Kotwall et al. (61) found a higher probability of breast-conserving surgery among self-pay/Medicaid/Medicare patients (OR = 2.4, 95 percent CI: 1.4, 4.2), as opposed to those with private insurance, but this study was conducted in a single regional medical center in North Carolina on a relatively small sample of 634 cases. Although surgery with breast preservation does not necessarily represent better care for breast cancer, the need for additional radiation therapy and the requirement for resources of the whole procedure probably explain why this treatment is more readily available to women having more extensive insurance coverage.

By contrast, a few investigations failed to show any relation between the pattern of care and insurance status (8, 14, 30, 57). In two of them, appropriateness of care was defined...
as either a management score obtained by contrasting clinical and treatment data (8) or a two-step surgical procedure, not type of surgery per se (30). The other two studies (14, 57), both conducted in Australia, did adjust to some extent for differences in case mix, and negative findings with regard to patterns of surgical treatment could reflect local differences in the organization of care, as well as cultural differences, compared with the situation in North America.

Assessment of care in health maintenance organizations, for its part, suggests that quality of care for breast cancer among members of health maintenance organizations is at least equivalent to care provided in fee-for-service settings. Lee-Feldstein et al. (33) compared patients admitted in health maintenance organizations and community hospitals in Orange County, California, between 1984 and 1990 and found better survival rates in large community hospitals (relative risk RR = 0.74, 95 percent CI: 0.59, 0.94) and significantly worse rates in health maintenance organizations (RR = 1.63, 95 percent CI: 1.16, 2.30) than in small community hospitals, after adjusting for age at diagnosis, tumor size, number of involved nodes, and surgical treatment received. This contrasts with the majority of studies on this issue, including two on Medicare beneficiaries by Potosky et al. (55) and Riley et al. (66), that showed greater likelihood of adequate locoregional management of women aged 65 years or older admitted in health maintenance organizations. Three other publications by Guadagnoli et al. (58, 59) and Vernon et al. (40) found equivalent management of or survival after breast cancer in health maintenance organizations and other centers. All these studies extensively adjusted for differences in case mix, but comorbidity was not taken into account in two of them (33, 40).

Altogether, studies on payment status and management of breast cancer suggest that women having more protection are more likely to receive appropriate diagnostic work-up, as well as less invasive procedures and treatment consistent with current standards of practice.

**CHARACTERISTICS OF THE ATTENDING PHYSICIAN**

The association between individual characteristics of the attending physician and treatment or outcomes of breast cancer has been assessed repeatedly. The most consistent finding is that better care is offered by clinicians having more experience with this disease, either because they are specialized in treating it (35, 44, 52, 65), have more years in practice (30, 59, 67), or see a larger volume of cases each year (21, 36, 48, 56, 60). Table I summarizes the main features of studies on the annual caseload of breast cancer patients of physicians and the care provided.

In one study conducted by Ferguson et al. (13) in a single medical center in Atlanta, Georgia, surgery with breast preservation and radiotherapy was less likely when women with stage I and II disease were treated by surgeons who cared for five or more cases each year, compared with those who had a smaller caseload (0–20 percent vs. 35 percent of cases, p = 0.001). No further adjustment was performed. Two other studies found an individual effect of the physician not explained by any personal attribute (43, 54). Moritz et al. (54) evaluated 600 women aged 49–79 years from the South East Thames region with invasive tumor less than 2 cm and found that surgeons operating on more than 20 such cases in a year had a lower mastectomy rate, although this difference disappeared after adjustment for case mix. Strong individual variation among physicians was observed, however, that could not be explained by measured variables. The second study was conducted by Hislop et al. (43) on all 942 node-negative cases diagnosed in British Columbia in 1991 and found a strong surgeon effect on the probability of breast-conserving surgery not explained by gender, year of graduation, academic affiliation, and caseload, after adjustment for patient and tumor characteristics. This contrasts with two subsequent publications by the same group that showed a significant association between the surgeon’s year of graduation and the probability of breast-conserving surgery in crude analysis (from 56.7 percent to 33.3 percent for surgeons who graduated in 1980 or later to 1950 or earlier, overall p for trend = 0.006) (51), as well as higher compliance with guidelines for systemic therapy among women referred to an oncology specialist (52), after taking into account the type of hospital (cancer center vs. community) and patient characteristics. This underscores the importance of proper adjustment for all relevant potential confounders. Finally, four additional investigations, three of them population based (11, 27, 62), concluded that the process or outcomes of care for breast cancer do not substantially vary with the attending physician (11, 18, 27, 62), but none of them did simultaneously adjust for characteristics of the hospital of treatment.

The most reliable evidence about the relation between the experience of the physician and care for breast cancer comes from those few investigations that simultaneously considered characteristics of the patient, her physician, and the hospital of treatment in multivariate analytical models. All such studies did confirm that management of the disease varies according to the attending clinician. Among these, Satiriano et al. (21) used data on 2,238 patients from the metropolitan Detroit area Surveillance, Epidemiology, and End Results program database in 1985–1987 to study the association between the clinician caseload and locoregional management of breast cancer, while adjusting for hospital size and the patient’s age, race, marital status, and year of admission. Surgeons with a larger caseload were more likely to perform breast-conserving surgery with radiation therapy (OR = 1.28, 95 percent CI: 1.03, 1.58 for those with >50 vs. ≤50 cases each year). Hynes (30) estimated the influence of the physician’s experience and research activities, while controlling for insurance coverage, size, type of hospital (Community Clinical Oncology Program vs. other community), and case mix as reflected by age, race, and nodal status, on the probability of two-step surgical procedures and rehabilitation therapy in 3,972 women with breast cancer across the United States selected from the National Cancer Institute Community Cancer Care Evaluation. Experienced physicians were more likely to perform two-step surgery (OR = 1.01, 95 percent CI: 1.00, 1.03) but also less likely to order rehabilitation therapy (OR = 0.97, 95 percent CI: 0.96, 0.98).
<table>
<thead>
<tr>
<th>Author (ref. no.)</th>
<th>Year</th>
<th>Location (no. of cases)</th>
<th>Aspects of care studied</th>
<th>Adjustment variables</th>
<th>Significant findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann et al. (11)</td>
<td>1988</td>
<td>New Mexico, United States (n = 6,030)</td>
<td>Surgical treatment Radiation therapy</td>
<td>Case mix (age, stage)</td>
<td>No association of BCS* and radiation therapy with surgeon caseload</td>
</tr>
<tr>
<td>Ferguson et al. (13)</td>
<td>1990</td>
<td>Atlanta, United States (n = 183)</td>
<td>Surgical treatment Radiation therapy</td>
<td></td>
<td>BCS with radiation therapy more likely with surgeons' having a larger caseload</td>
</tr>
<tr>
<td>Satariano et al. (21)</td>
<td>1992</td>
<td>Detroit, United States (n = 2,238)</td>
<td>Surgical treatment Radiation therapy</td>
<td>Case mix (age, race, marital status), year of admission</td>
<td>BCS with radiation therapy more likely with surgeons' having a larger caseload</td>
</tr>
<tr>
<td>Byrne et al. (27)</td>
<td>1993</td>
<td>Western Australia (n = 662)</td>
<td>Diagnostic investigations Surgical treatment Radiation therapy Systemic adjuvant therapy</td>
<td>Case mix (age, deprivation, extent of disease, tumor grade)</td>
<td>No association of BCS with surgeon caseload</td>
</tr>
<tr>
<td>Sainsbury et al. (36)</td>
<td>1995</td>
<td>Yorkshire, United Kingdom (n = 12,861)</td>
<td>Surgical treatment Radiation therapy Systemic adjuvant therapy Survival</td>
<td></td>
<td>Combined therapy and survival more likely with surgeons' having a higher caseload</td>
</tr>
<tr>
<td>Hislop et al. (43)</td>
<td>1996</td>
<td>British Columbia, Canada (n = 942)</td>
<td>Surgical treatment</td>
<td>Case mix (age, residence, income, tumor size, histology, location, extent of DCIS*)</td>
<td>Physician effect not explained by measured variables</td>
</tr>
<tr>
<td>Dixon et al. (48)</td>
<td>1996</td>
<td>Edinburgh, United Kingdom (n = 152)</td>
<td>Surgical treatment</td>
<td>Case mix (tumor size, nodal status, type, invasiveness, mammographic appearance, EIC,* localization, volume of excision)</td>
<td>Completeness of excision and BCS more likely with surgeons' having a higher caseload</td>
</tr>
<tr>
<td>Olivotto et al. (52)</td>
<td>1997</td>
<td>British Columbia, Canada (n = 661)</td>
<td>Radiation therapy Systemic adjuvant therapy State-of-the-art treatment</td>
<td>Case mix (age, residence, income, tumor size, margins, type, HR,* grade, location, focality, LVNI,* extent of DCIS, no. of nodes sampled)</td>
<td>Referral to a specialist oncologist decreased with surgeon caseload</td>
</tr>
<tr>
<td>Moritz et al. (54)</td>
<td>1997</td>
<td>South East Thames, United Kingdom (n = 600)</td>
<td>Surgical treatment Radiation therapy Systemic adjuvant therapy</td>
<td>Case mix (tumor size, nodal status, grade)</td>
<td>Treatment not associated with caseload</td>
</tr>
<tr>
<td>Stevenson et al. (56)</td>
<td>1997</td>
<td>Western Australia (n = 692)</td>
<td>Survival</td>
<td></td>
<td>Physician effect not explained by measured variables</td>
</tr>
<tr>
<td>Goy et al. (60)</td>
<td>1998</td>
<td>South East Thames, United Kingdom (n = 1,029)</td>
<td>Radiation therapy</td>
<td></td>
<td>Radiation therapy more likely with surgeons' having a higher caseload</td>
</tr>
<tr>
<td>Twelves et al. (62)</td>
<td>1998</td>
<td>Scotland, United Kingdom (n = 2,148)</td>
<td>Survival</td>
<td>Case mix (age, deprivation, tumor size, nodal status, stage, HR, treatment)</td>
<td>Survival not associated with surgeon caseload</td>
</tr>
</tbody>
</table>

* BCS, breast-conserving surgery; DCIS, ductal carcinoma in situ; EIC, extensive intraductal component; HR, hormone receptors; LVNI, lymphatic, vascular, or neural invasion.
Kotwall et al. (45), in a statewide analysis of all cases of primary breast cancer in North Carolina between 1988 and 1993, observed that recently graduated surgeons were more likely to perform breast-conserving surgery (OR = 1.6, 95 percent CI: 1.2, 2.0), independently of the patient's age and insurance status and of the hospital bed size. Guadagnoli et al. (58, 59) compared the management of stage I and II breast cancer in Massachusetts and Minnesota during the period 1993–1995 and evaluated the association of locoregional and systemic treatment with insurance coverage, hospital characteristics (including on-site availability of the specialized resources needed for cancer treatment), and surgeon's gender, year of graduation, and board certification. Extensive resources needed for cancer treatment), and surgeon's gender, year of graduation, and board certification. Extensive adjustment was done for demographic and disease characteristics and comorbidity. Although use of breast-conserving surgery was not related to board certification or years since graduation, surgeons with more experience were more likely to prescribe radiation therapy after breast-conserving surgery in Massachusetts (OR = 3.8, 95 percent CI: 1.2, 12.0 for those with ≥30 vs. <10 years since graduation) but not in Minnesota (OR = 1.3, 95 percent CI: 0.2, 10.7). Finally, Hébert-Croteau et al. (67) also focused on the management of stage I and II breast cancer in Quebec, a region with a universal free-of-charge health care system, during the period 1988–1994, and studied the association of locoregional treatment with the time since graduation of the attending clinician, hospital breast cancer caseload, and participation in multicenter clinical trials, adjusting for case mix (age at diagnosis, characteristics of the disease, and comorbidity). Surgeons with 30 or more years in practice were twice as likely to provide treatment consistent with consensus recommendations after adjustment for other covariates (OR = 2.0, 95 percent CI: 1.4, 2.9).

Overall, these data suggest that compliance with practice guidelines, an indicator of quality of care, tends to increase with the experience of the attending physician. In addition, breast-conserving surgery was more likely with younger or more recently graduated physicians in several investigations (45, 51, 61, 65); this suggests that therapeutic innovations find easier application when they are learned through a basic educational curriculum than when learned afterward. No clear threshold for a desirable physician breast cancer caseload can be identified from these data, the numbers of 5 (13), 20 (48, 56), 30 (36), and 50 (21) cases per year having been reported as significantly associated with the patterns or outcomes of treatment.

**Characteristics of the Hospital of Treatment**

Among all the organizational aspects of care for breast cancer, the characteristics of the hospital of treatment have been the most extensively investigated. As for the physician caseload, greater bed size of the treatment center and, more importantly, cancer or breast cancer annual caseload have been shown to favorably influence the process of care (7, 16, 21, 24, 38, 45, 47, 53, 59) and especially to increase the probability of surgery with breast preservation (21, 24, 38, 45, 47) and, in some instances, survival (33, 63). Studies on this issue are listed in table 2.

A few publications describe the performance of Italian hospitals. The Interdisciplinary Group for Cancer Care Evaluation (7) studied 1,262 newly diagnosed cases of breast cancer admitted into 63 general hospitals in 1983–1984. The relation between diagnostic investigations and staging, surgical treatment, radiation therapy, systemic adjuvant therapy, and state-of-the-art treatment with type of hospital (member or not of the Italian Breast Cancer Task Force), hospital size, and on-site radiotherapy, oncology, and pathology showed that staging was more likely in large hospitals (82 percent vs. 76 percent, p < 0.05) and in those with oncology facilities (81 percent vs. 66 percent, p < 0.001). On-site availability of radiation facilities influenced the probability of a woman's receiving radiotherapy. In addition, breast-conserving surgery in younger women was more likely in hospital members of the Italian Breast Cancer Task Force and with on-site oncology departments. In a subsequent publication by the same group on a subset of 353 patients, no difference in the frequency of chemotherapy could be detected when hospitals were grouped according to size, although the likelihood of receiving this treatment was greater in those members of the Italian Breast Cancer Task Force (10). Grilli et al. (24) used the original database and evaluated if inappropriate Halsted mastectomy varied with volume across hospitals. Inappropriate interventions were less likely to be performed in centers with a large volume of cases (OR = 0.36, 95 percent CI: 0.23, 0.55 for those with >20 vs. ≤10 patients each year, adjusted for education, tumor size, and nodal status).

Several studies in the United States have also confirmed the association between the hospital bed size or breast cancer caseload and the pattern of care for breast cancer. In particular, Johantgen et al. (38) found a positive association of breast-conserving surgery with hospital size, the odds ratios in hospitals with <100 and 100–249 beds being 0.90 (95 percent CI: 0.83, 0.98) and 0.95 (95 percent CI: 0.89, 1.01), respectively, as compared with ≥250 beds. These estimates are adjusted for age, extent of disease, comorbidity, payment status, race, hospital location, teaching status, and region. A similar observation was made by Nattinger et al. (19, 47) on 81,762 Medicare beneficiaries admitted in 1986 or 1990 into 3,632 hospitals across the United States. Although bed size was not an independent predictor of breast-conserving surgery in 1986 (19), the time trend showed that the percentages of this intervention in hospitals with ≤125 beds, 126–300 beds, and 301–400 beds were 10.0 percent, 13.7 percent, and 15.6 percent in 1986 and 9.5 percent, 14.2 percent, and 17.3 percent in 1990 (p values for comparison of 1986 and 1990 = 0.40, 0.29, and <0.001, respectively). When the volume of breast cancer operations was the predictor of interest, the percentages of breast-conserving surgery in centers with <13, 13–23, and ≥24 cases per year were 11.9 percent, 14.2 percent, and 16.6 percent in 1986 and 11.9 percent, 15.5 percent, and 19.3 percent in 1990 (p values for comparison of 1986 and 1990 = 0.84, 0.007, and <0.001, respectively).

In addition, two other investigations (33, 63) showed that survival is better for women treated in larger hospitals. The first study by Lee-Feldstein et al. (33) was conducted in...
California over the period from 1984 to 1990 on 5,892 cases admitted into 126 hospitals. This study showed better survival in large compared with small community centers (RR of dying = 0.74, 95 percent CI: 0.59, 0.94 for localized disease; RR = 0.74, 95 percent CI: 0.60, 0.91 for regional disease, adjusted for age, tumor size, histology, nodal extension, and locoregional treatment). The second investigation by Roohan et al. (63) used the New York State hospital discharge database between 1984 and 1989 and found that treatment in very low volume hospitals was associated with a 60 percent greater risk of all-cause mortality (RR of dying = 1.6, 95 percent CI: 1.42, 1.81 for very low- vs. high-volume centers), after adjusting for the type of surgery and the patient’s age, stage, comorbidity, race, socioeconomic status, and distance to hospital.

Taken together, these studies on hospital volume lead to two main observations. Some of them suggest that individuals admitted into very small hospitals are more likely to have adverse features of their disease at presentation, to receive suboptimal treatment, especially omission of radiation therapy or inadequate assessment of the status of the axilla, and to experience adverse outcomes. In addition, several studies have shown a trend for several indicators of quality of care, including better survival, to increase with hospital caseload, although a leveling off of this effect beyond a minimal threshold cannot be clearly ruled out.

Studies on this issue are not, however, unanimous. Several reports have found no independent association (8, 15, 19, 26, 28, 31, 49) or even a negative association (9, 12, 30, 37, 39, 67) between hospital caseload and the probability of conservatively treated disease, state-of-the-art management, or survival. It is unclear why the hospital bed size or caseload does not consistently emerge as a significant predictor of care received or survival. Several of these investigations were population based, therefore minimizing potential selection bias resulting from specific referral patterns, and were conducted on very large study populations. Although most did perform some adjustment for individual characteristics of patients, comorbidity was rarely taken into account. In a minority of studies (12, 21, 30, 45, 58, 59, 67), characteristics of the physician responsible for treatment were also considered. Differences in the categorization of caseload and in the definition of high- and low-volume centers might also explain some of the discrepancies in results across studies. Finally, with respect to the organization of services in hospitals, often correlated with the volume of cases, could have been operational but were not systematically considered. For example, large hospitals usually have an academic affiliation, and teaching status itself has been associated with a greater probability of breast-conserving surgery or adequate locoregional management (12, 19, 20, 23, 33, 34, 37, 38, 41, 46, 51, 58), with better systemic treatment (17, 20, 23), or even in some cases with better survival (20, 28). This is not unique to breast cancer and has been shown for several other health conditions as well (68, 69). In addition, better quality of care, including greater access to surgery with breast preservation, has been reported in urban centers (19, 38, 39, 42, 57), although not unanimously so (9, 16, 22, 49). On-site availability of specialized equipment sometimes has been associated with better care, again including greater likelihood of breast-conserving surgery (7, 12, 19, 37, 46, 47). Although little difference has been shown according to the type of hospital in several studies (15, 26, 30, 47), a few investigations have suggested that the process of care is better in cancer centers (50, 52), in centers with participation in breast cancer control activities (7, 10), and in private hospitals (12, 17, 39). All of these characteristics usually reflect a larger proficiency of resources in a given environment and could account, at least to some extent, for the association of hospital volume with the process or outcomes of treatment.

**CLUES FOR RESEARCHERS AND PLANNERS OF HEALTH SERVICES**

What conclusions can then be reached about the organization of health services most likely to result in optimal care and offering the best chances of survival to women with breast cancer? Several of the associations reported here for breast cancer had also been observed by Donabedian (5) almost two decades ago in his general overview. It is better recognized today that factors associated with the process or outcomes of treatment tend to vary across different health conditions or procedures (70, 71).

Although the literature is not consistent, there are several indications that a larger caseload promotes the adoption of technologic or therapeutic innovations by clinicians and treatment centers, such as breast-conserving surgery or use of systemic adjuvant treatment. This, however, is not systematically equivalent to better treatment. For example, it has been repeatedly demonstrated that surgery with breast preservation tends to be used more frequently in larger centers (21, 24, 38, 45, 47). With regard to consensus recommendations for combining this surgery with radiation therapy and dissection of the axilla (72), however, the available evidence sometimes led to an opposite conclusion (67). Studies aimed at evaluating indications for and appropriateness of treatments could therefore provide a different account of the association between volume and quality of care for breast cancer. In addition, analytical issues, especially the use of several categorizations for caseload, while adjusting for other physician and hospital characteristics, need to be properly addressed (73). Finally, as has been emphasized (71, 73), the association between volume and patterns of care could in fact result from selective referral of individuals with favorable prognostic features in larger centers and not from better performance with increasing practice. This alternative explanation seems unlikely, given that many studies included in this review adjusted, at least partially, for differences in case mix.

Our interpretation of the literature and its policy implications needs to be cautious. First, it is obvious from this overview that an important volume of research on quality of care for breast cancer, and for other health problems as well (74), suffers from methodological weaknesses, especially failure to take into account all significant potential confounders. Because virtually all studies in this area are observational, improper adjustment for differences in case mix, the definition of which is closely dependent on the aspect of care studied (75), has been a limitation in several investiga-
<table>
<thead>
<tr>
<th>Author (ref. no.)</th>
<th>Year</th>
<th>Location (no. of cases)</th>
<th>Aspects of care studied</th>
<th>Adjustment variables</th>
<th>Significant findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIVIO* (7)</td>
<td>1986</td>
<td>Italy (n = 1,262)</td>
<td>Diagnostic investigations Staging Surgical treatment Radiation therapy Systemic adjuvant therapy State-of-the-art treatment</td>
<td></td>
<td>Staging more likely in large hospitals</td>
</tr>
<tr>
<td>Greenfield et al. (8)</td>
<td>1987</td>
<td>Southern California, United States (n = 374)</td>
<td>Treatment score reflecting appropriate diagnosis, staging, and initial therapy</td>
<td>Case mix (age, stage, comorbidity)</td>
<td>Hospital variation not explained by differences in bed size</td>
</tr>
<tr>
<td>Mettlin et al. (9)</td>
<td>1987</td>
<td>United States (n = 27,442)</td>
<td>Survival</td>
<td>Case mix (age, race, stage, histology, HR,* treatment), size of metropolitan area</td>
<td>Survival less likely in large hospitals</td>
</tr>
<tr>
<td>GIVIO (10)</td>
<td>1988</td>
<td>Italy (n = 353)</td>
<td>Systemic adjuvant therapy (chemotherapy)</td>
<td>Case mix (nodal status)</td>
<td>No independent association with hospital bed size</td>
</tr>
<tr>
<td>Diehr et al. (12)</td>
<td>1989</td>
<td>United States (n = 7,781)</td>
<td>Diagnostic investigations HR assay Radiation therapy Rehabilitation</td>
<td>Case mix (age, stage)</td>
<td>Less appropriate care in large hospitals</td>
</tr>
<tr>
<td>Bonett et al. (15)</td>
<td>1991</td>
<td>South Australia (n = 2,589)</td>
<td>Survival</td>
<td>Case mix (age, tumor size, nodal status)</td>
<td>No association of survival with hospital bed size</td>
</tr>
<tr>
<td>Hand et al. (16)</td>
<td>1991</td>
<td>Chicago, United States (n = 6,766)</td>
<td>Stage at diagnosis HR assay ALN* dissection Radiation therapy Rehabilitation</td>
<td>Case mix (age)</td>
<td>Late stage and omission of radiation therapy more likely in hospitals with smaller caseloads</td>
</tr>
<tr>
<td>Nattinger et al. (19)</td>
<td>1992</td>
<td>United States (n = 36,982)</td>
<td>Surgical treatment</td>
<td>Case mix (race, nodal status), size of metropolitan area</td>
<td>No independent association with hospital bed size</td>
</tr>
<tr>
<td>Satariano et al. (21)</td>
<td>1992</td>
<td>Detroit, United States (n = 2,238)</td>
<td>Surgical treatment Radiation therapy</td>
<td>Case mix (age, race, marital status), year of admission</td>
<td>BCS* with radiation therapy more likely in large hospitals</td>
</tr>
<tr>
<td>Grilli et al. (24)</td>
<td>1993</td>
<td>Northern and central Italy (n = 985)</td>
<td>Surgical treatment</td>
<td>Case mix (age, marital status, occupation, education, tumor size, nodal status, stage)</td>
<td>Inappropriate Halsted procedure less likely in large hospitals</td>
</tr>
<tr>
<td>Boffetta et al. (26)</td>
<td>1993</td>
<td>Piedmont, Italy (n = 4,764)</td>
<td>Survival</td>
<td>Case mix (age, marital status, occupation, area of birth), year of diagnosis, town size</td>
<td>No association of survival with hospital caseload</td>
</tr>
<tr>
<td>Tanaka et al. (28)</td>
<td>1994</td>
<td>Osaka, Japan (n = 7,377)</td>
<td>Survival</td>
<td>Case mix (age, stage, treatment)</td>
<td>No independent association with hospital bed size</td>
</tr>
<tr>
<td>Hynos (30)</td>
<td>1994</td>
<td>United States (n = 3,972)</td>
<td>Surgical treatment Rehabilitation</td>
<td>Case mix (age, race, nodal status)</td>
<td>Two-step surgical procedure and rehabilitation less likely in large hospitals</td>
</tr>
<tr>
<td>Iscoe et al. (31)</td>
<td>1994</td>
<td>Ontario, Canada (n = 12,815)</td>
<td>Surgical treatment</td>
<td>Case mix (age, county)</td>
<td>BCS associated with individual hospital practices, not hospital caseload</td>
</tr>
<tr>
<td>Study</td>
<td>Year</td>
<td>Location</td>
<td>Methodology</td>
<td>Characteristics and Findings</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>---------------------------------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Lee-Feldstein et al. (33)</td>
<td>1964</td>
<td>California, United States</td>
<td>Surgical treatment, Radiation therapy</td>
<td>Survival better in large community hospitals</td>
<td></td>
</tr>
<tr>
<td>Scorpiglione et al. (37)</td>
<td>1995</td>
<td>Italy (n = 1,724)</td>
<td>Surgical treatment</td>
<td>Inappropriate Halsted procedures more likely in large hospitals</td>
<td></td>
</tr>
<tr>
<td>Johantgen et al. (38)</td>
<td>1995</td>
<td>United States (n = 87,449)</td>
<td>Surgical treatment</td>
<td>BCS more likely in small hospitals</td>
<td></td>
</tr>
<tr>
<td>Grilli and Repetto (39)</td>
<td>1995</td>
<td>Lombardia, Italy (n = 6,961)</td>
<td>Surgical treatment</td>
<td>BCS more likely in large hospitals</td>
<td></td>
</tr>
<tr>
<td>Kotwall et al. (45)</td>
<td>1996</td>
<td>North Carolina, United States</td>
<td>Surgical treatment</td>
<td>BCS more likely in large hospitals</td>
<td></td>
</tr>
<tr>
<td>Nattinger et al. (47)</td>
<td>1996</td>
<td>United States (n = 81,762)</td>
<td>Surgical treatment</td>
<td>Change in BCS from 1986 to 1990 more likely in large hospitals</td>
<td></td>
</tr>
<tr>
<td>Hillner et al. (49)</td>
<td>1996</td>
<td>Virginia, United States</td>
<td>Stage at diagnosis, ALN dissection, Radiation therapy, Systemic adjuvant therapy</td>
<td>No independent association with hospital bed size</td>
<td></td>
</tr>
<tr>
<td>Ma et al. (53)</td>
<td>1997</td>
<td>North East Thames, United Kingdom (n = 306)</td>
<td>Pathology report and pathologic staging, Surgical treatment, Radiation therapy, Systemic adjuvant therapy</td>
<td>Availability of FNA, access to specialist surgeon, and larger number of nodes excised more likely in hospitals with larger caseloads</td>
<td></td>
</tr>
<tr>
<td>Guadagnoli et al. (58)</td>
<td>1998</td>
<td>Massachusetts and Minnesota, United States (n = 2,575)</td>
<td>Surgical treatment</td>
<td>No independent association with hospital bed size</td>
<td></td>
</tr>
<tr>
<td>Guadagnoli et al. (59)</td>
<td>1998</td>
<td>Massachusetts and Minnesota, United States (n = 2,575)</td>
<td>ALN dissection, Radiation therapy, Systemic adjuvant therapy</td>
<td>Radiation therapy after BCS more likely in hospitals with &gt;100 beds (Massachusetts)</td>
<td></td>
</tr>
<tr>
<td>Roohan et al. (63)</td>
<td>1998</td>
<td>New York State, United States</td>
<td>Survival</td>
<td>Auxiliary dissection more likely in hospitals with ≥500 beds (Massachusetts)</td>
<td></td>
</tr>
<tr>
<td>Hébert-Croteau et al. (67)</td>
<td>1999</td>
<td>Quebec, Canada (n = 1,174)</td>
<td>Surgical treatment</td>
<td>State-of-the-art treatment less likely in large hospitals</td>
<td></td>
</tr>
</tbody>
</table>

* GIVIO, Interdisciplinary Group for Cancer Care Evaluation; HR, hormone receptors; ALN, axillary lymph nodes; BCS, breast-conserving surgery; FNA, fine-needle aspiration; SES, socioeconomic status.
tions. Attempts have been made to better characterize the strength and direction of the resulting bias (76). Further assessment of the variables most critical to this end, as well as their correlation and independent association with the process or outcomes of treatment, is needed.

Second, few evaluative studies have been performed that took advantage of ongoing reforms and mergers of health services to confirm the influence of some organizational features of health services (74). These reforms have often been undertaken following economic incentives to do so, under the assumption that better efficiency and economies of scale would result (74, 77). They could offer unique opportunities to confirm some relations, for example, with hospital volume, in the context of longitudinal, controlled observations.

Finally, few attempts have been made to assess the impact of the organization of health services on such relevant outcomes of breast cancer as quality of life, recurrences, and disease-free survival. Because locoregional management has not been shown to influence survival except in very specific subgroup of cases (4, 78, 79), and given the recognized necessity to follow women with carcinoma localized to the breast for long periods of time in order to detect a survival advantage associated with specific therapeutic options (80), such studies are needed before firm conclusions can be reached about the organization of health services most suitable for breast cancer control.

Several initiatives to improve quality of care to women with breast cancer have been undertaken in recent years (81). Among them, treatment guidelines and consensus development conferences have been used extensively (72, 80, 82–87). Although their impact on actual medical practice has often been modest (88–95), some recent studies suggested that publication of guidelines, either as clinical alerts or formal sets of recommendations for treatment, has at times been followed by appropriate changes in case management (96, 97). This has been shown to be more likely when implementation strategies using several sets of incentives have been used (98, 99). For its part, state legislation to oblige disclosure of treatment options by physicians has had only a mitigated success regarding the use of breast-conserving surgery (100).

In the United States, the implementation of the Community Clinical Oncology Program after 1982 has been another effort, sponsored by the National Cancer Institute, to promote the participation of community hospitals in collaborative clinical trials and to foster cancer prevention and control activities over a broad scope of research projects (101–106). The basic principle underlying this and other similar initiatives, such as the cancer outreach programs of the large cancer centers (107), is to offer access to state-of-the-art treatment while maintaining individuals as close to their home as possible. This concern, often expressed by individuals with cancer and their families, has been taken into account in the reform of oncology services undertaken in several areas in recent years (108), and it should be incorporated in future evaluative studies on quality of care for breast cancer.

Overall, more research is needed before decisions can safely be made on the type and organization of services most likely to contribute to breast cancer control. This is an important domain of investigation, likely to have major implications for women afflicted with this disease, professionals involved in their treatment, and health administrators as well.

ACKNOWLEDGMENTS

This review was performed in the context of an operating grant from the Fonds de la Recherche en Santé du Québec.

REFERENCES

19. Nattinger AB, Gottlieb MS, Veum J, et al. Geographic variation in the use of breast-conserving treatment for breast can-


63. Arnold RE, Frykberg ER, Kilkenny JW, et al. Trends in sur-