An Academic Health Center Cost Analysis of Screening Mammography

Creating a Financially Viable Service

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BACKGROUND. The current study sought to determine the institutional financial impact of a screening mammography (SM) program in the context of an integrated cancer center.

METHODS. Using administrative databases, 10,048 women were identified as receiving screening mammograms in fiscal year 1999 and the first one-half of fiscal year 2000. The utilization of breast care resources was followed for an average of 1208 days. The University of Michigan cost accounting system was then used to determine overall margin (revenues − total costs) and contribution margin (revenues − actual costs) of the SM program, as well as other breast care services.

RESULTS. The percentage of variable costs to total costs for the SM program was 24%. The overall facility losses in the breast care line were $1.7 million with a positive contribution margin of $2.0 million. The annual yield of nonscreening/diagnostic mammographic procedures was 0.9%. All types of radiologic activity failed to cover their total costs, but did provide a positive contribution margin. Overall margins for surgery procedures were approximately even, and adjuvant medical and radiotherapy services were net positive. Modeling helped to identify overhead limits necessary to achieve margin targets associated with increased activity.

CONCLUSIONS. The current study showed that SM programs are unlikely to succeed financially without careful selection of those screened to increase the yield of diagnostic and therapeutic procedures. Based on favorable contribution margins, SM programs were viable when viewed as incremental business. ***Cancer* 2004;101: 1043–50.** © *2004 American Cancer Society.*

KEYWORDS: cost analysis, mammography, breast care, cancer screening.

There have been few public health screening activities that have been as highly debated and heavily publicized as screening mammography. Large population studies have demonstrated decreased breast carcinoma mortality in groups screened using mammography. At the same time that advocates have encouraged an expansion of screening, mammography screening centers have been closing with 124 centers closing between October 2002 and May 2003 alone.[1] Many cite a lack of remuneration and high professional liability risks as the reason for this decline.[2] A study by Enzmann et al.[3] demonstrated that at least on the professional fee side, reimbursement did not even cover the costs of performing the examination. However, little is known as to whether the same is true for a hospital or radiology center.

We undertook the current study to examine the financial impact of a mammographic screening program within an academic health

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center. The analysis excluded professional reimbursements and focused on the facility reimbursement. We hypothesized that screening mammography, despite being potentially unprofitable, would generate subsequent visits to higher profit centers within the hospital such as interventional radiology, surgery, medical oncology, and radiation oncology that would offset the losses on screening mammography.

MATERIALS AND METHODS

Patient Population

Patients were assigned coded numbers to eliminate patient identifiers. The University of Michigan institutional review board approved a waiver of consent. All patients receiving screening mammograms in fiscal year (FY) 1999 and the first one-half of FY2000 (n = 10,048) at the University of Michigan Health System (UMHS) were identified for the study using the hospital cost accounting system (TSI [Eclipsys], Boca Raton, FL). These were patients who underwent an outpatient visit using only a single resource logged as "screening mammography–bilateral," which is specific for patients who have had no previous risk factors for breast diseases (e.g., history of breast mass, strong family history, previous breast biopsies, or malignancies). Patients who received both a diagnostic mammogram and a screening mammogram on the same day were logged as diagnostic mammograms. For the purposes of the current study, we also included patients with bilateral diagnostic mammograms who did not have a diagnosis of previous breast pathology. Patients referred for second opinions or outside screening mammograms were excluded. This yielded 10,048 distinct patients.

Resource Utilization

Patients were tracked for resource utilization of breast care services from their index visit (their first screening mammogram in FY1999 or the first one-half of FY2000) through May 31, 2002. This provided a 2–3-year follow-up of resource utilization. Costs as experienced by the institution were derived using the University of Michigan Health System Data Warehouse (HSDW), which contains data on all outpatient and inpatient visits within the UMHS from 1996 to the present. Costs were split into variable direct costs (i.e., costs such as radiographic film supplies, pharmaceuticals, and other supplies used), fixed direct costs (i.e., fixed costs of nonhourly staff required to run a unit and local capital expenditures such as radiography equipment), and indirect costs (i.e., general institutional overhead such as hospital executive compensation and portion of financing). Revenues were derived from the HSDW based on the historically based estimated net revenue that each patient's insurance provider generally provided to our institution for each service. Charges were also tracked using actual billed charges. Overall margin was defined as the difference between revenue and total costs. Contribution margin was defined as the difference between revenue and variable costs (i.e., actual costs).

TABLE 1
Patient Demographics

Age (yrs)	No. of patients	(%)
< 40	558	(5.6)
40–49	4030	(40.1)
50–59	2915	(29.0)
60–69	1407	(14.0)
> 69	1138	(11.3)
Total	10,048	(100.0)

Subsequent visits by defined patient cohorts and the timing of those visits were identified through the accounting systems and breast care items were manually abstracted. We defined diagnostic mammography as all mammography that was not listed with the identifier, screening mammography–bilateral. This included all unilateral mammograms, and mammograms that were listed with a nonscreening diagnosis. Interventional radiology included all breast biopsies performed in the radiology suites that were identified by procedure codes (e.g., ICD-9) and/or supply codes (an internal cost accounting mechanism). Surgery included all procedures performed on the breast subsequent to an initial screening mammogram as identified by appropriate ICD-9 codes. Medical oncology included all chemotherapy infusions and radiation oncology included all visits for external-beam radiation, both identified by a combination of procedure codes and supply codes. Other cancers were excluded by matching the interventions with an appropriate breast carcinoma diagnosis code.

For the purposes of grouping, inpatient encounters were bundled into one visit, and all related laboratories performed on the day of outpatient intervention encounters (e.g., interventional radiology, surgery, medical oncology, and radiation oncology) were bundled into the encounter statistics. The index screening mammogram for each patient was defined as Time 0, and all time points were calculated from that point.

Modeling Methods

Modeling of the impact of changing various parameters was performed using Microsoft Excel 2000 (Microsoft, Bellevue, WA). To analyze the impact of

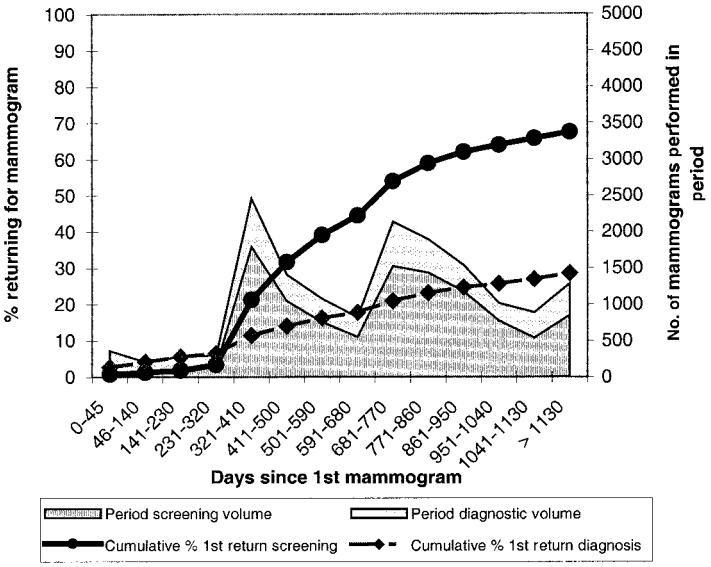

FIGURE 1. Return mammography utilization.

changing payer mix, patients were subtracted from the test group and redistributed using the proportions of each other type of payer for that specialty's services. To analyze the impact of changes in yield, the overall 3-year yield was varied for all subsequent services beyond screening mammograms, using the assumption that their relative utilizations would stay constant (i.e., the proportion of operations to chemotherapy visits was held constant). A comparison of age groups was performed starting after Year 1, which was excluded to minimize potential bias from referral patterns into our health center. Productivity improvements were modeled by doubling overall screening populations, doubling variable costs, and varying the amount of overhead assigned to each service.

RESULTS

Patient Demographics and Yield of Follow-Up Services

Demographic data of our patient population demonstrated a fairly typical screening population, with 45.7% of patients being < 50 (Table 1). Follow-up utilization of mammography services exhibited numerous spikes in usage (most notably at yearly intervals). However, 32.5% of patients initially screened did not return to our institution for any breast-related care in the follow-up time period (Fig. 1). Patients requiring a subsequent diagnostic mammography visit showed a fairly steady accumulation, with 28.5% requiring ≥ 1 nonscreening mammogram during the follow-up period.

For the total time followed, 3.1% of patients received ≥ 1 nonscreening, nondiagnostic mammographic service, for an annual average of 0.9% of patients per year (Fig. 2). Some patients with a

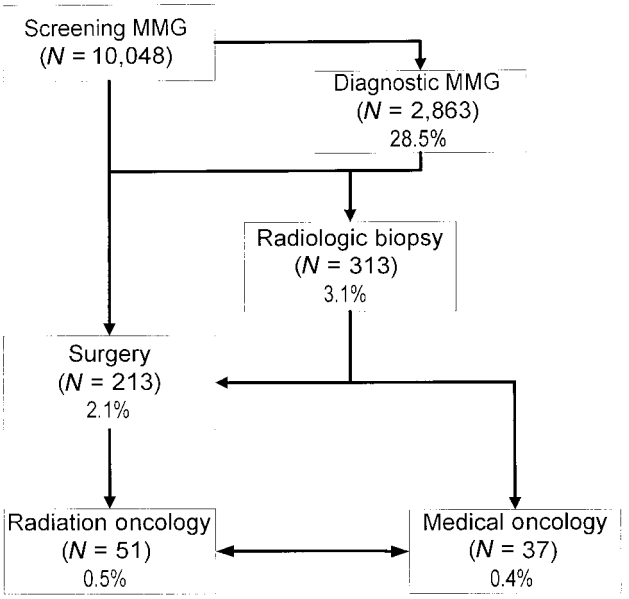

FIGURE 2. Yield of nonmammographic services. MMG: mammography.

subsequent diagnosis of cancer may have had services rendered by multiple disciplines. When broken down to services rendered by each discipline, 3.1% of patients received a procedure in radiology, 2.1% subsequently received ≥ 1 surgical procedure, 0.5% received services from medical oncology, and 0.4% received services from radiation oncology. These nonscreening/diagnostic mammographic service yields differed when the cohort was split by age group. In Years 2 and 3, patients ≥ 50 years averaged an annual yield per patient of 1.1% whereas patients < 50 years averaged 0.9%.

TABLE 2
Cost Breakdown by Service

Characteristics	Index mammogram	Follow-up screening	Diagnostic mammography	Interventional radiology
No. (unique patients)	10,048	6,769	2,863	313
Total cost	$1,332,386	$1,131,531	$653,866	$323,794
Variable cost	$205,687	$212,257	$127,419	$94,156
Charges	$896,524	$1,278,698	$887,355	$332,075
Revenue	$411,027	$605,963	$438,555	$154,532
Margin	−$921,359	−$525,568	−$215,311	−$169,262
Contribution margin	$205,340	$393,706	$311,136	$60,376
Charge/cost ratio	67%	113%	136%	103%
Collection rate	46%	47%	49%	47%

	Surgery	Medical oncology	Radiation oncology	Total
No. (unique patients)	201	37	51	10,048
Total cost	$763,420	$356,185	$376,164	$4,937,346
Variable cost	$272,040	$198,945	$75,084	$1,185,588
Charges	$1,523,449	$645,093	$1,034,838	$6,598,032
Revenue	$708,262	$429,181	$459,056	$3,206,577
Margin	−$55,158	$72,996	$82,892	−$1,730,769
Contribution margin	$436,222	$230,236	$383,972	$2,020,989
Charge/cost ratio	200%	181%	275%	134%
Collection rate	46%	67%	44%	49%

HMO: Health Maintenance Organization.

Margin Analysis

The average variable cost per screening mammogram for the initial period was $20.47. The aggregate overall margin for the initial screening mammogram service was −$921,359. However, the contribution margin was $205,340, indicating that the service does cover its actual costs, but not the total overhead that is attributed to it (Table 2). Of all breast care-related services, only radiation oncology and medical oncology yielded a profit based on overall margins. Other radiology services such as interventional radiology (including biopsies) as well as diagnostic mammography (all nonscreening mammograms) operated at a loss overall (Table 2). Notably, the screening mammography program submitted aggregate charges that were less than total costs, whereas therapeutic specialties such as surgery, medical oncology, and radiation oncology submitted charges far in excess of costs. Collection rates were similar across specialties, except for medical oncology, which collected approximately 67% of its charges.

A breakdown by types of payer demonstrated widely differing margins for any given service (Table 3). Some payers yielded a positive overall margin for some services, whereas others were consistently negative across all services. Capitated health maintenance organizations (HMOs) represented the lowest group of payers, with no patients covering their total allocated costs. Commercial payers as well as Blue Cross/Blue Shield indemnity plans tended toward the best margins.

Fixed costs were broken down into unit-specific overhead and hospital overhead for each service via the cost accounting database that uses an activity-based cost system. Unit-specific overhead varied from 40% to 76% of the total overhead assigned, with an overall average of 50% (Fig. 3).

Scenario Modeling

In modeling service expansion scenarios, we considered the impact of various levels of overhead expansion if screening populations were doubled at the outset. Our model (Fig. 4) demonstrated that to ensure that margins did not worsen for the entire breast care center, overhead would have to expand at $< 54\%$ if volumes were doubled. Smaller overhead expansions lead to better margins, with a 7.7% overhead expansion allowing the entire center to become a break-even (overall margin = 0) proposition.

Financial modeling estimated that for each 10% of all patients that can be shifted away from capitated contracts to noncapitated contracts, $238,355 could be gained in overall margins over the period studied, assuming that all other variables (i.e., total volume, charges, and yields) were held constant. Eliminating the HMO patients entirely, while keeping all else equal including the other relative payer mix, still resulted in an overall negative margin of −$423,425. This would

TABLE 3
Payer Mix Detail

Payer type	Screening mammograms			Diagnostic mammograms			Interventional radiology visits		
	Average overall margin	Average contribution margin	Encounters (%)	Average overall margin	Average contribution margin	Encounters (%)	Average overall margin	Average contribution margin	Encounters (%)
Capitated HMOs	−$84	$11	51.5	−$76	$32	48.1%	−$592	−$3	51.3
Blue Cross/Blue Shield	−$45	$52	23.0	−$8	$98	26.6	−$283	$352	27.3
Commercial	−$42	$55	11.9	$3	$113	12.1	−$236	$311	9.1
Medicare	−$67	$29	13.2	−$43	$63	12.9	−$403	$319	12.0
Medicaid	−$70	$26	0.3	−$59	$47	0.3	−$541	$147	0.3

	Surgery visits			Chemotherapy visits			Radiation oncology visits		
	Average overall margin	Average contribution margin	Encounters (%)	Average overall margin	Average contribution margin	Encounters (%)	Average overall margin	Average contribution margin	Encounters (%)
Capitated HMOs	−$1058	$466	58.8	−$286	$157	58.5	−$959	$4,351	64.9
Blue Cross/Blue Shield	$1202	$2581	24.8	$1060	$1866	22.6	$6404	$11,853	28.1
Commercial	$1391	$2758	8.1	$1357	$1916	15.3	$4093	$8256	5.3
Medicare	$545	$1934	8.4	−$216	$226	12.8	$3631	$8567	1.8
Medicaid			0.0			0.0			0.0

HMO: health maintenance organization.

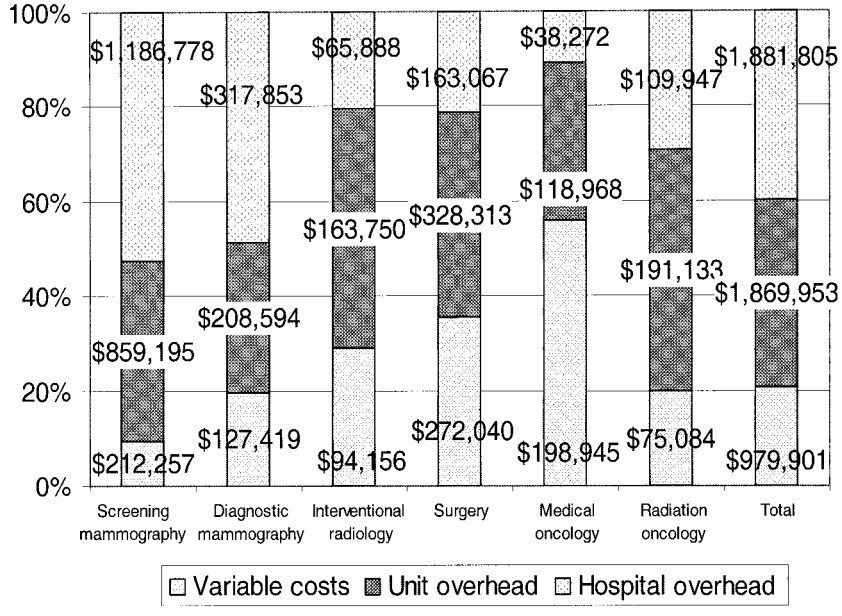

FIGURE 3. Cost category breakdown.

indicate that the payer mix change would either need to be targeted to fill the gap or that the payer mix would need to be combined with other changes to reach a break-even result. Modeling based on potential yield changes demonstrated that if the yield could be increased from 3.1% to 4.1% (chosen to correspond to the 32% increased risk of developing breast carcinoma in women 50–60 years old),[4] contribution margins would improve by $1,054,068 when all other variables were held constant. However, without some savings in overhead, or changes in the relative yields of the nonradiologic procedures compared with diagnos-

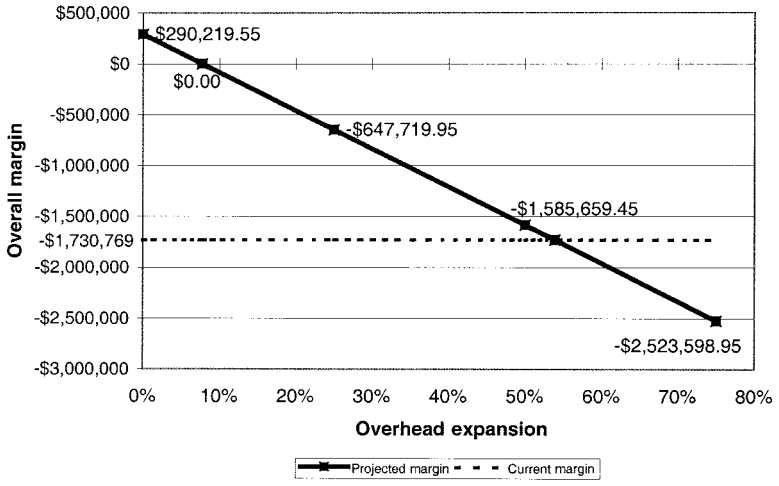

FIGURE 4. Overhead expansion versus overall margin.

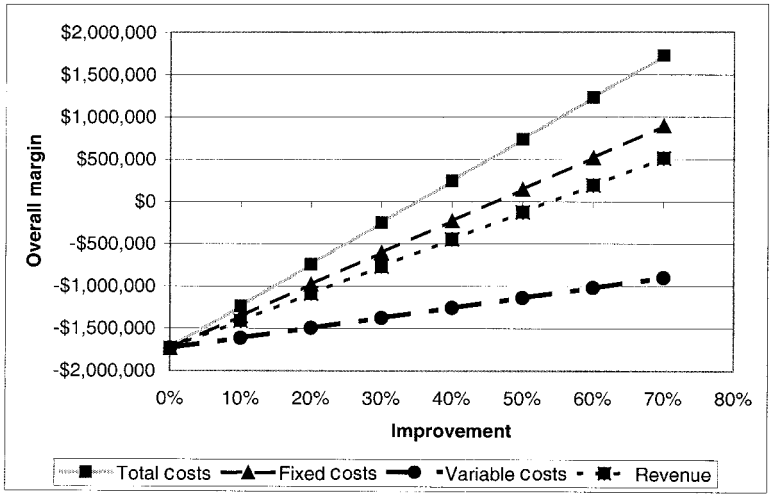

FIGURE 5. Break-even analysis.

tic and further screening, expansion of volume would not improve overall margins.

A break-even analysis was performed. Break-even results could be achieved by improving revenues per service or by lowering the cost of each service (Fig. 5). For total costs, a 35% reduction across the board would bring overall margins to zero. For revenues, a hike of 54% would be required to reach a break-even result, assuming that all other items (i.e., volume, payer mix, costs) remained constant.

DISCUSSION

Few public health measures in the United States have engendered as much passion and discussion as screening mammography. The majority of studies have demonstrated a mortality benefit for populations screened, with the impact varying by the underlying risk factors such as age and family history.[5] Advocates have pushed for improving access to screening mammography across the entire eligible population in an attempt to bring the benefits of this intervention to as many women as possible. Simultaneously, however, screening mammography programs are scaling back or closing altogether, with the result being backlogs at the remaining centers.[6] The causes for this reduction in supply, even in the face of burgeoning demand, are attributed, at least in part, to poor reimbursement and high costs of providing this service, particularly in the professional liability climate of today.[7] Our study demonstrates one possible reason why facilities may not be interested in filling the gap.

Our study demonstrates the difficulties in running a dedicated screening mammography unit. The losses incurred by screening mammograms alone during the index period were $921,359. More importantly, no payer reimbursed sufficiently to cover the overhead associated with performing the procedure for any given patient. Reimbursements by national payers

were comparable to published fee schedules by Medicare, which ranged from < $60 per mammogram to approximately $80 in the most recent fee schedule. By only covering the variable costs, screening mammography would only be a profitable service when considered as a purely incremental service, i.e., to fill excess capacity that is not used by other radiologic services. However, because virtually all mammography units are running at capacity and most have significant backlogs, this strategy dooms screening to a position where there will never be enough capacity to meet demand.

Alternately, we have shown that an integrated cancer center can use mammography services to generate profitable services (i.e., medical oncology and radiation oncology), which can potentially subsidize the losses incurred by the unprofitable service, namely, screening mammography. Careful control of a number of factors is required to utilize this pathway to financial viability when providing mammography services. First, a focus on yield is key to maintaining a logical connection between mammograms and profitable cancer treatments. When capacity is limited, a focus on high-risk patients who will undergo more diagnostic and therapeutic interventions beyond just screening should be considered. This will allow cancer centers to utilize their limited resources to better fulfill their missions of outreach to the community in detecting cancers, as well as treating cancers as they occur. It is important to recognize that this situation also matches what most people would consider optimal triage, namely, prioritizing high-risk patients to receive a limited resource first. Another aspect of screening mammography that we did not analyze was the impact the screened population would have on the medical institution for referral of non–breast-related services. This was beyond the scope of the current study.

Next, a focus on payer mix and relative reimbursement rates is important to achieve financial viability. It is noteworthy that for radiology services, our institution typically charged close to the total cost of care. Given our 46–49% collection rate, this was a key financial disadvantage. A reexamination of charges is an important component of rationalizing the financial situation. Furthermore, in capitated contracts where charges are irrelevant, the allocation of the contract monies internally should recognize the importance of screening mammography as the portal to other forms of care. When health centers have captive or preferred health plans, it is important to consider the effect of the transfer price applied between the two units as well. Setting these prices too low will make the clinical unit appear to be doing poorly and will discourage the unit from seeking out patients who come from this insurance group. In our case, our own capitated HMO was indeed ranked as the lowest payer, and the preponderance of these patients significantly impacted the overall finances of the entire breast center as it related to the screened population. Our modeling demonstrated that small shifts of patient population groups could make an impact in the overall bottom line.

Finally, the issues of throughput and fixed asset productivity need to be considered. In our institution, the contribution margins were positive, whereas the overall margin was negative. Our variable costs comprised 24% of the total costs in contrast to other institutions, which have reported variable costs as low as 15% of the total costs.[8] Low variable costs relative to total costs mean that an unprofitable service may, indeed, result in eventual profits. This is only true, however, when allocated fixed costs do not increase as fast as volume increases. To the extent that reengineering the process can allow mammography centers to perform more examinations out of their existing infrastructure, or only expand part of their infrastructure (e.g., by increasing the clinical staff, but not increasing the administrative staff), the losses in mammography centers will decrease. Our modeling indicated that increasing our clinical volume with projected limits on overhead increases would allow the breast care center to improve financially. Productivity must be balanced against quality and it would be foolhardy for a system to exceed its capacity, thus leading to poorer outcomes. However, to the extent that inefficiencies in care delivery can be avoided, better financial outcomes may be matched with an equivalent or better clinical outcome.

Our study contains an assumption that is important to highlight. We used a rules-based accounting system that divides costs into variable, fixed direct, and indirect costs. Although we have used these rules for planning and evaluating the performance of our clinical units, no cost accounting system can give a full picture of what truly occurs within any complex system. Thus, some items that are variable in one respect (e.g., computer time used to type a dictation report) are often considered to be fixed for simplicity. This may introduce bias into the profitability of one unit of the hospital compared with another. However, because these are the data that our finance department uses in developing strategic plans, we believe that these are the relevant data to use. If other institutions were to utilize different accounting assumptions, they may develop different conclusions regarding the balance between contribution and overall margins. Furthermore, our status as an academic health center

necessarily complicates our accounting system because revenues for the institution can come from different sources. We have chosen to focus the current analysis on clinical revenues. Our accounting system posts costs by each item used and service provided, which best matches clinical costs with clinical revenues. Occasionally, research needs may necessitate running a loss in any one service, which could potentially be made up for in research revenues that exceed costs to the facility. This situation should be analyzed separately from the clinical cost/revenue picture because it would still be important to recognize that the service does not pay its own way.

The generalization of our specific data is also difficult to determine. Although nationwide reports from both private and public providers have stated that reimbursements are inadequate, every hospital works within a cost milieu that may not be similar to ours in the cost of equipment, labor, or the ease of acquisition of patients. Other facilities may be able to negotiate lower costs or garner higher reimbursements. Therefore, instead of presenting our data as representative of cancer centers across the country, we demonstrate the key factors that determine the profitability of a screening mammography program in an integrated cancer center. Given our data, it would certainly be more profitable to not perform screening mammography at all if we could continue to operate at capacity in performing cancer therapies. However, given that screening programs have been proven to reduce breast carcinoma mortality rates, the relevant question that we faced is, "How can the provision of this service be justified financially?"

Providing screening mammography services will continue to be a challenge as poor reimbursement will most likely continue in this era of cost-cutting by insurers and rapid increases in health care costs paid by our patients. It is likely that small mammography units will continue to struggle in this milieu. Centers that provide integrated cancer services will most likely have to take up the slack. Attention to the guideposts of appropriate charges, yield, payer mix, and productivity may help these surviving centers avoid similar fates.

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