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Purpose: There are multiple current strategies for breast radiotherapy (RT). The alignment of physician practice patterns with best evidence and patient preferences will enhance patient autonomy and improve cancer care. However, there is little information describing patient preferences for breast RT and physician practice patterns.
Methods and Materials: Using a reliable and valid instrument, we assessed the preferences of 5,000 randomly selected women (with or without cancer) undergoing mammography. To assess practice patterns, 2,150 randomly selected physician-members of American Society for Radiation Oncology were surveyed.
Results: A total of 1,807 women (36%) and 363 physicians (17%) provided usable responses. The 95% confidence interval is < ±2.3% for patients and < ±5.3% for physicians. Patient preferences were hypofractionated whole breast irradiation (HF-WBI) 62%, partial breast irradiation (PBI) 28%, and conventionally fractionated whole breast irradiation (CF-WBI) 10%. By comparison, 82% of physicians use CF-WBI for more than 2/3 of women

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CLINICAL INVESTIGATION

PATIENT PREFERENCES AND PHYSICIAN PRACTICE PATTERNS REGARDING BREAST RADIOTHERAPY

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Purpose: **There are multiple current strategies for breast radiotherapy (RT). The alignment of physician practice patterns with best evidence and patient preferences will enhance patient autonomy and improve cancer care. However, there is little information describing patient preferences for breast RT and physician practice patterns.**
Methods and Materials: **Using a reliable and valid instrument, we assessed the preferences of 5,000 randomly selected women (with or without cancer) undergoing mammography. To assess practice patterns, 2,150 randomly selected physician-members of American Society for Radiation Oncology were surveyed.**
Results: **A total of 1,807 women (36%) and 363 physicians (17%) provided usable responses. The 95% confidence interval is < ±2.3% for patients and < ±5.3% for physicians. Patient preferences were hypofractionated whole breast irradiation (HF-WBI) 62%, partial breast irradiation (PBI) 28%, and conventionally fractionated whole breast irradiation (CF-WBI) 10%. By comparison, 82% of physicians use CF-WBI for more than 2/3 of women and 56% never use HF-WBI. With respect to PBI, 62% of women preferred three-dimensional (3D)-PBI and 38% favor brachytherapy-PBI, whereas 36% of physicians offer 3D-PBI and 66% offer brachytherapy-PBI. 70% of women prefer once-daily RT over 10 days vs. twice-daily RT over 5 days. 55% of physicians who use PBI do not offer PBI on clinical trial.**
Conclusions: **HF-WBI, while preferred by patients and supported by evidence, falls behind the unproven and less preferred strategy of PBI in clinical practice. There is a discrepancy between women's preferences for PBI modality and type of PBI offered by physicians. Further alignment is needed between practice patterns, patient preferences, and clinical evidence.** **© 2011 Elsevier Inc.**

Patient preference, Partial breast irradiation, Hypofractionation, Practice patterns, Breast cancer.

INTRODUCTION

A host of clinical trials have established breast irradiation as an integral component of breast conservation therapy (BCT) (1). In modern practice, there are multiple methods of delivering breast radiotherapy (RT). Strategies differ in schedule, volume of tissue irradiated, and in the degree we understand their safety and efficacy (Fig. 1).

Conventionally fractionated whole breast irradiation (CF-WBI) targeting the entire breast with 1.80–2.00 Gy once daily is supported by more than a dozen Phase III trials (1). A lumpectomy cavity boost is commonly added to CF-WBI. Disadvantages of CF-WBI include the prolonged treatment course (5–7 weeks), delivery of ionizing radiation to sites within the breast remote from the lumpectomy bed,

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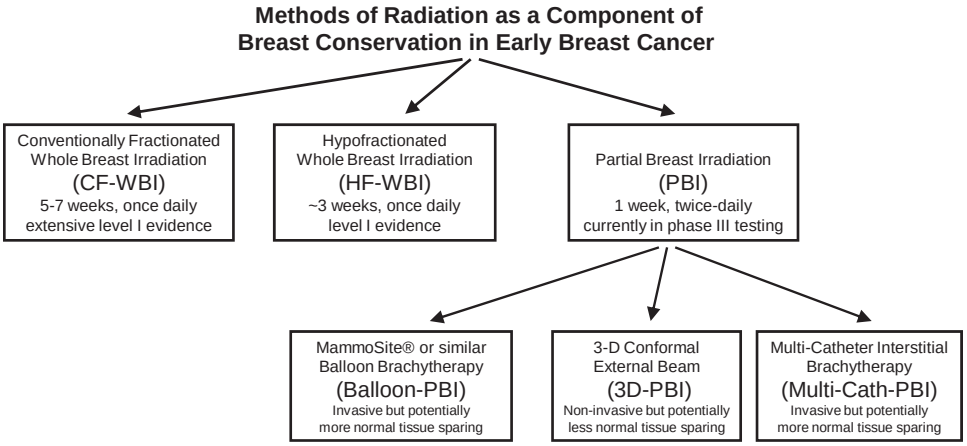

Fig. 1. Methods of radiation as a component of breast conservation in early breast cancer. CF-WBI = conventionally fractionated whole breast irradiation; HF-WBI = hypofractionated whole breast irradiation; PBI = partial breast irradiation; balloon-PBI = MammoSite or similar balloon brachytherapy; 3D-PBI = three-dimensional conformal external beam; multi-cath-PBI = multi-catheter interstitial brachytherapy.

and radiation dose to surrounding normal structures including the lungs and heart.

Two general strategies have been employed in an attempt to improve on CF-WBI: shortening the total treatment time (hypofractionation) and irradiation of less than the entire breast (partial breast irradiation; PBI). Hypofractionated whole breast irradiation (HF-WBI) treats the entire breast for roughly 3 weeks at 2.66–3.20 Gy once daily. HF-WBI regimens have been tested in randomized trials against CF-WBI. These trials have shown no difference in disease-free survival, overall survival, or toxicity profile with significant follow-up (2–6).

PBI focuses radiation to a portion of the breast and accelerates the treatment duration. In the United States, typical PBI strategies deliver 10 fractions of 3.40–3.85 Gy twice daily over 5 days. Although Phase I-II trials of such PBI have been reported, quality randomized trials with long follow-up are limited (4). Currently, the National Surgical Adjuvant Breast and Bowel Project (NSABP) is conducting a Phase III trial (B-39) comparing CF-WBI with PBI. B-39 has not yet met accrual and mature results are not expected for years.

Adding to the complexity, there are multiple methods of delivering PBI, including balloon brachytherapy PBI (Balloon-PBI; *e.g.*, MammoSite, Hologic Inc., Bedford, MA), three-dimensional (3D) conformal external beam PBI (3D-PBI), multicatheter brachytherapy PBI (Multi-Cath-PBI) and single fraction intraoperative PBI. Our survey project predates the recent publication of two large experiences with single fraction intraoperative PBI (7, 8).

With the advent of BCT, a considerable amount of data has been generated evaluating the decision between mastectomy and breast conservation (9–12). The value of patient autonomy forms the bedrock of such research. Autonomy dictates that the patient should, and even must, make decisions about her treatment (13) (*voluntas aegroti suprema lex*: the will of the patient is the first law). Although much has been studied about what motivates patients and their physicians regarding the choice between mastectomy and breast conservation, we are unaware of any robust description of women's preferences and physician practice patterns for the major options in breast radiotherapy. Our intent is to report survey data describing American breast radiation practice patterns in light of level I evidence and considering survey findings evaluating patient's breast radiation preferences.

METHODS AND MATERIALS

Before commencement, this study was approved by the Institutional Review Boards of all governing institutions in accord with an assurance filed with and approved by the Department of Health and Human Services. The use of subjects in this research was compliant with the exemption requirements of 32 CFR Part 219 and AFI 40-402. The survey instruments are included in the Survey Appendix.

Survey instrument design and testing

Please see the Statistical Appendix for details and discussion. Both the physician and patient survey instruments were developed specifically for this project. Demographic items were designed based on the U.S. Census Bureau's 2007 American Community Survey (ACS) Questionnaire in English. The ACS has been rigorously tested and shown to be reliable (14). Content validity for both the patient and physician surveys was established using an expert review strategy described in standard statistical practices (15, 16).

Patient survey instrument reliability was established using a test-retest strategy with a four week intra-test interval on consecutive women with American Joint Committee on Cancer Stage 0-II breast cancer from the Wright-Patterson tumor registry. Dichotomous variables with a correlation coefficient of >0.69 were accepted as reliable. For multichrotomous variables, an index of inconsistency was calculated and values <0.51 were considered reliable. After several iterations of testing and item revision, all but one item returned with a correlation >0.69 or an index of inconsistency <0.51. The single outstanding item returned with an

Table 1. Demographics of responding physicians

	Academic		Private Practice		VA/DoD		Not currently practicing	
	%	SE	%	SE	%	SE	%	SE
Practice setting in the past year	20.5	2.1	77.4	2.2	2.1	0.9	0	N/A
	Solo Practice		2–3		4–10		>10	
	%	SE	%	SE	%	SE	%	SE
Practice group size (number of radiation oncologists)	11.3	1.7	34.8	2.5	39.4	2.5	14.5	1.7
	None		1–20		21–50		>50	
	%	SE	%	SE	%	SE	%	SE
Number of new, curative intent, breast cancer patients treated each year	1.6	0.7	9.4	1.5	35.4	2.5	53.6	2.7
	Northeast		South		Midwest		West	
	%	SE	%	SE	%	SE	%	SE
Geographic region of practice	20.6	2.2	34.7	2.7	24.5	2.2	20.1	2.1

Abbreviations: SE = standard error; VA = Veterans Administration; DoD = Department of Defense.

index of inconsistency of 0.565 but a simple response variance of 0.125. As described in our Statistical Appendix, this was likely due to the rarity of one answer choice and we accepted this item for testing.

Deployment of final survey instruments

The final patient survey included 30 multiple choice items designed for optical scanning and was mailed January to February 2009 to 5,000 women with or without a cancer diagnosis selected from the mammography databases of Wright-Patterson Medical Center, Wright-Patterson Air Force Base, OH; Clarian Health/Indiana University, Indianapolis, IN; and Wilford Hall Medical Center, Lackland Air Force Base, TX. A cover letter assured participants that no individually identifiable information would be disseminated. Surveys were returned via mail using enclosed, stamped, addressed envelopes. No reminders were used for nonresponders. We assumed that all mailings reached eligible women and calculated response rate based on the 2009 Response Rate 2 (RR2) definition (17). Receipt of patient surveys closed in May 2009 with 1,807 usable responses received (36% response rate).

The final physician survey consisted of 15 multiple choice items and was mailed between October and November 2008 to 2,150 randomly selected active physician members of the American Society for Radiation Oncology. A cover letter assured participants that no individually identifiable information would be disseminated. Surveys were returned via facsimile. No reminders were used for nonresponders. We assumed that all mailings reached eligible physicians and calculated response rate based on the RR2 definition (17). Receipt of physician surveys closed in January 2009 with 363 usable responses (17% response rate).

Table 2. Physician practice patterns for women who receive postlumpectomy radiation

In women you deem to require postlumpectomy RT, how often do/would you use each of the following RT strategies?

	% reporting		% reporting		% reporting		% reporting	
	None/never	SE	<1/3	SE	1/3 to 2/3	SE	>2/3	SE
4. CF-WBI	0.9	0.5	2.5	0.8	14.8	1.8	81.8	2.0
5. HF-WBI	56.2	2.5	40.7	2.5	2.6	0.7	0.5	0.3
6. Balloon-PBI	44.5	2.5	49.6	2.5	5.5	1.2	0.3	0.3
7. 3D-PBI	64.1	2.4	33.5	2.3	1.7	0.7	0.6	0.4
8. Multicath-PBI	89.1	1.6	9.9	1.5	0.6	0.4	0.3	0.3
9. Other RT strategy	10 physicians listed a “free text” description							
	% reporting		% reporting		% reporting		% reporting	
	None/never	SE	<1/3	SE	1/3 to 2/3	SE	>2/3	SE
10. Boost after CF-WBI	0	0	0.8	0.4	4.8	1.1	94.4	1.2
11. Boost after HF-WBI	69.7	2.3	10.0	1.5	5.9	1.2	14.4	1.8
12. % HF-WBI on trial	81.9	1.9	14.8	1.8	0.4	0.3	2.8	0.8
13. % PBI on trial	55.1	2.5	23.0	2.1	6.9	1.2	15.0	1.8

Abbreviations: SE = standard error; CF-WBI = conventionally fractionated whole breast irradiation; HF-WBI = hypofractionated whole breast irradiation; PBI = partial breast irradiation; 3D = three-dimensional conformal external beam; multicath = multicatheter brachytherapy; RT = radiotherapy.

Please see the Survey Instrument Appendix for item details.

Table 3. Physician multivariate analysis

Item	Significant predictors	Details
4. Use of CF-WBI	None	
5. Use of HF-WBI	Practice group size ($p = 0.0001$)	Smaller practices tend to offer HF-WBI less often than larger practices.
6. Use of Balloon-PBI	Geographical region ($p = 0.0385$)	Southern region offers more balloon-PBI than the Midwest or the Northeast.
	Patients' volume ($p = 0.0006$)	Physicians seeing >50 new breast cases/year offer more balloon-PBI than those seeing fewer cases.
	Practice type ($p < 0.0001$)	Private practice offers more balloon-PBI than academic (OR 3.18; 95% CI 1.69–6.00).
	Practice group size ($p < 0.0001$)	Solo physicians offer less balloon-PBI than larger groups.
7. Use of 3D-PBI	Practice type ($p = 0.0087$)	Academic physicians offer more 3D-PBI than private practice providers (OR 0.44; 95% CI 0.25–0.75).
	Geographic region ($p = 0.0004$)	West and Midwestern regions offer more 3D-PBI than the Northeast or South.
8. Use of multicath-PBI	None	
9. Free text item not evaluated in multivariate analysis		
10. Boost after CF-WBI	None	
11. Boost after HF-WBI	Practice group size ($p = 0.0163$)	Smaller practice groups generally offer fewer boosts following HF-WBI than larger groups.
12. HF-WBI clinical trial	None	
13. PBI clinical trial	Practice type ($p = 0.0017$)	Academic physicians offer more PBI on clinical trial than private practice providers (OR 0.45; 95% CI 0.26–0.76)
	Practice group size ($p = 0.0019$)	Solo physicians offer less PBI on clinical trial than the larger group sizes
14. Reason for choosing and RT regimen	None	

Abbreviations: CF-WBI = conventionally fractionated whole breast irradiation; HF-WBI = hypofractionated whole breast irradiation; PBI = partial breast irradiation; 3D = three-dimensional conformal external beam; multicath = multicatheter brachytherapy; RT = radiotherapy.

Statistical analysis

For both physician and patient surveys, we used imputation strategies for responses containing missing items. For all but one item, a cell mean strategy was used, based on similar items from the same respondent. The only item for which a regression strategy was used for imputation was age in the patient survey.

Analysis was performed using SAS release 9.1 (SAS Institute, Cary, NC)and R release 2.9 (R Development Core Team, Vienna, Austria). In SAS we used the surveyfreq, surveymeans, and surveylogistic with the institution as a stratum and weights as described in the Statistical Appendix. In R, we used svyglm and associated functions from the survey package. Measures of association were tested using the Wald chi-square test and results were considered statistically significant at the alpha = 0.05 level.

We fit multivariate models using logistic regression. The data were stratified by institution in the patient analysis and by practice type and region in the physician analysis. Backward elimination was used to identify significant factors. In some cases it was necessary to combine related response categories to ensure adequate responses in each category. Although they were incorporated in modeling, final results for subgroups with limited numbers of responses (*e.g.*, ≤7) were ignored.

RESULTS

Demographics of physician respondents

More than three-fourths of respondents were in private practice and the majority described treating more than 50 new curative intent breast cancer patients each year. Table 1 details the physicians surveyed.

Physician practice patterns for radiation treatment modality

Physicians were asked how often they use the BCT irradiation regimens, including the various PBI techniques, in women who merit postlumpectomy radiation. Data are in Table 2. CF-WBI is offered by nearly all radiation oncologists (95% CI, 98.2–100.0%) and is used more than twice as often as any other irradiation schedule. Balloon-PBI was second most employed irradiation technique with 55.5% of radiation oncologists performing the procedure (95% CI, 50.6–60.4%). This was significantly higher than the 43.8% who report offering HF-WBI (95% CI, 38.9–48.7%), the 35.9% who offer 3D-PBI (95% CI, 31.2–40.6%) and the 10.9% who offer Multi-Cath-PBI (95% CI, 7.8–14.0%). Further, HF-WBI was performed in at most 16% of patients and more than half of radiation oncologists never use HF-WBI. Physicians reported the most important reason for selecting a breast irradiation strategy as Level I evidence, 75.6% (95% CI, 71.3–79.9%), normal tissue sparing, 14.5% (95% CI, 11.0–18.0%), patient convenience, 9.4% (95% CI, 6.5–12.3%) and reimbursement potential, 0.5% (95% CI, 0–1.1%).

Physician clinical trial and lumpectomy cavity boost activity

More than 72% of women treated with PBI are not enrolled on a prospective clinical trial (Table 3). In addition, more than half of physicians who offer PBI never enroll PBI patients on clinical trial. When delivering CF-WBI, a lumpectomy cavity boost is used in more than two-thirds of women by nearly all physicians, whereas the majority women receiving HF-WBI do not receive a boost.

Physician multivariate analysis

Multivariate analysis was performed on the physician responses evaluating the following predictors: practice group size, practice type, patient volume, and geographical region. Significant predictors were revealed for the use of HF-WBI, Balloon-PBI, 3D-PBI, lumpectomy cavity boost following HF-WBI, and the frequency with which PBI is delivered as part of a clinical trial. Please see Table 3 for details.

Demographics of patient respondents

Women who responded to our patient survey were largely Caucasian, without children in the home, whom receive their healthcare through TRICARE (the US Department of Defense Health Care Program) or the Veterans Administration. The average age of patient respondents was 57.7 years (Table 4).

Table 4. Demographics of responding patients

	%	95% CI
Race		
White or Caucasian	77.3	75.3–79.3
Black or African American	12.0	10–13.6
American Indian or Native	0.4	0.1–0.7
Hispanic	6.6	5.5-7.7
Asian	3.8	2.9–4.7
Household total income in last 12 months		
$0–30,000	12.8	11.2 –14.4
$30,001–50,000	15.9	14.1–17.6
$50,001–75,000	26.4	24.4 –28.5
$75,001–100,000	21.5	19.5–23.4
>$100,000	23.4	21.4–25.4
Highest level of education completed		
Less than high school diploma	3.8	2.9–4.7
High school graduate or equivalent	39.7	37.4–42.1
Associate degree	17.7	15.9–19.5
Bachelor's degree	21.1	19.2–23.1
Graduate school degree	17.6	15.7–19.4
Primary health insurance coverage*		
No health insurance	1.0	0.5–1.6
TRICARE or VA benefit	65.3	64.2–66.3
Medicare or Medicaid	9.0	7.6–10.4
Self-purchased insurance	2.2	1.4–3.0
Insurance provided by an employer	22.5	21.0–24.0
Current driver's license	97.3	96.5–98.1
Drove last week	91.6	90.3–92.9
Currently work outside the home		
No	47.4	45.1–49.7
Yes, <20 h/week	8.4	7.1–9.6
Yes, 21–40 h/week	25.8	23.7-27.9
Yes, 41–60 h/week	17.2	15.4–19.1
Yes, > 60 h/week	1.3	0.7–1.8
Children 17 years old or younger in the home	23.3	21.3–25.3
Time to drive from home to nearest radiation center		
<10 min	10.1	8.6–11.5
10–20 min	39.5	37.2–41.8
20–30 min	31.8	29.6–34.0
30–60 min	14.0	12.4–15.7
More than 1 h	1.6	1.0–2.2
Did not know	3.0	2.2–3.7

Abbreviations: CI = confidence interval; TRICARE = US Department of Defense Health Care Program; VA = Veteran's Administration.

* Totals may be >100% as multiple responses were permitted.

Patient preferences for radiation treatment modality and schedule

After descriptions of the CF-WBI, HF-WBI, and PBI radiation regimens, and assuming that all regimens are equally effective at treating cancer with the same side effects, women were asked their preference.

HF-WBI was preferred by 61.7% of patients (95% CI, 59.4–64.0%). This was significantly higher than 28.1% who preferred PBI (95% CI, 26.0– 30.3%) and the 10.1% who preferred CF-WBI (95% CI, 8.7–11.5%). Furthermore, in no subset examined (state of residence, education, income, race, insurance, driver's license, work outside the home, children in the home and drive time) was there a statistically significant preference for any modality other than HF-WBI.

Women also gave their preference for a once-a-day treatment over 10 days vs. twice-a-day over 5 days, with at minimum 6 h between treatments and assuming no difference in cancer control or side effects. A total of 70.1% of women (95% CI, 67.9–72.3%) preferred once-daily RT for 10 days compared with 29.9% of women (95% CI, 27.7–32.1%) who preferred the twice-daily option.

Patient preferences for partial breast irradiation modality

Patients were presented with information describing brachytherapy PBI vs. 3D-PBI. A total of 61.5% of women preferred 3D-PBI (95% CI, 59.2–63.9%), whereas 38.5% of women (95% CI, 36.1–40.8%) chose brachytherapy PBI. When asked the most important reason for their PBI modality choice, 60.4% of women answered "I want to avoid anything placed inside my breast" compared with 39.6% selecting "I want to minimize the radiation to my normal body."

Patient multivariate analysis

Multivariate analysis was performed on the patient responses evaluating the following predictors: age, race, income, education, insurance, driver's license, drove in the past week, work outside the home, children age 17 or

Table 5. Patient multivariate analysis

Item	Significant predictors	Details
12. CF-WBI vs. HF-WBI vs. PBI	Race ($p < 0.0001$)	Caucasians were more likely to prefer PBI than African Americans or Hispanics and less likely to prefer HF-WBI than Hispanics. African Americans were more likely to prefer CF-WBI than Caucasians.
	Income ($p = 0.006$)	As income increased the preference for PBI increased, whereas CF-WBI and HF-WBI decreased.
	Education ($p < 0.0001$)	As education increased the preference for PBI increased, whereas CF-WBI and HF-WBI decreased.
	Insurance ($p < 0.0001$)	Women with employer provided insurance were more likely to preferred PBI than those with Medicare/Medicaid.
	Child in home ($p = 0.03$)	Women without children in the home were more likely to prefer CF-WBI.
14. Once-daily vs. twice-daily	Age ($p = 0.0003$)	Older women were more likely to prefer 10 days of once-daily treatment.
	Race ($p < 0.0001$)	Caucasians were more likely to prefer 5 days of twice-daily treatment than African Americans or Hispanics.
	Education ($p < 0.0001$)	As education increased the preference for 5 days of twice-daily treatment increased.
	Cancer diagnosis ($p < 0.0001$)	Women with a prior breast cancer diagnosis were more likely to prefer 10 days of once-daily RT.
15. 3D-PBI vs. brachy-PBI	Income ($p = 0.0011$)	As income increased the preference for brachy-PBI increased.
	Cancer diagnosis ($p = 0.016$)	Women with a prior breast cancer diagnosis were more likely to prefer 3D-PBI.

Abbreviations: CF-WBI = conventionally fractionated whole breast irradiation; HF-WBI = hypofractionated whole breast irradiation; PBI = partial breast irradiation; RT = radiotherapy; 3D = three-dimensional conformal external beam; brachy = brachytherapy.

younger at home, drive time, and breast cancer diagnosis. A number of predictors were found to influence patient preference as detailed in Table 5.

DISCUSSION

Our research shows that the overwhelming majority of physicians deliver post-lumpectomy radiotherapy congruent with level I evidence. CF-WBI, as supported by a host of Phase III trials (1, 18), is delivered to more than two thirds of women by more than 80% of radiation oncologists.

The last decade has seen a radical change in breast cancer radiation. A large 1998–1999 national patterns of care study (19) found that 100% of women had received whole breast irradiation (WBI). No other breast RT strategy was reported. This WBI was almost universally CF-WBI. Our survey data (2008–2009) now indicate substantial proportions of U.S. radiation oncologists are delivering alternate breast RT strategies including 56% who offer Balloon-PBI, 44% who offer HF-WBI and 36% who offer 3D-PBI. Our project did not collect data on intraoperative PBI and recent initial reports of this modality (7, 8) dictate its inclusion in further evaluations of patient preferences or practice patterns.

As we consider the newer breast RT modalities, we uncover disconnects between physician practice patterns and level I evidence. At present, Balloon-PBI, the second most common RT modality, has no foundation in level I evidence and mature results from NSABP-B39 are years in the future. In comparison, HF-WBI, which does have the support of Phase III randomized trials from both Canada and the United Kingdom, is clearly offered less often than Balloon-PBI. More than half of radiation oncologists never offer HF-WBI.

One must always interpret practice patterns in light of available evidence. One may assert that radiation oncologists viewed the HF-WBI results as immature when our survey was conducted (October 2008). At the time of our physician survey, initial Canadian HF-WBI 5-year results had been long available (5) but mature 12-year outcomes had only been released in abstract. By October 2008, the first major British HF-WBI experience had been published with a nearly 10-year follow-up (20) and British START trials A and B had been published describing 5- and 6-year median follow-ups (2, 3). After our survey, mature 12-year Canadian HF-WBI results have since been published and continue to show equivalent tumor control and toxicity profiles between HF-WBI and CF-WBI (6).

However, even if one accepts the assertion that HF-WBI was immature in 2008, this does not explain how Balloon-PBI, which remains unsupported by Phase III trials, continued to be employed more often than HF-WBI. We recommend that American Radiation Oncologists make a formal evaluation of their individual practice patterns

and assure that the strategies they offer are congruent with best evidence. The recent long-term Canadian HF-WBI results (6), the recent ASTRO PBI consensus statement (4), and a soon to be published ASTRO consensus statement regarding whole breast fractionation merit special attention as physicians evaluate their practices.

In contrast to the physician survey, our patient data indicated that HF-WBI was more than twice as likely to be preferred by patients over any other modality, including PBI. Furthermore, this preference for HF-WBI was found in all subsets analyzed.

A major factor influencing women's preference for HF-WBI over PBI is likely an aversion to twice-a-day treatment. Nearly three times as many women preferred a theoretical once-daily irradiation over a twice-daily option even though the once-daily choice required twice the total treatment duration. Although questions of radiobiology remain, we believe that these data support the testing of novel once-daily PBI strategies in clinical trial.

One must exercise caution when comparing results of the physician survey with the patient preferences as the two projects were built on distinct paradigms. In the patient survey, women were asked to assume that tumor control and treatment-related toxicity were equivalent for all treatment strategies. Physicians were not asked to make such assumptions. Because American physicians should know the supporting evidence, and have personal experience delivering breast irradiation, they may perceive differences in tumor control and toxicity between the various breast irradiation strategies.

Another potential difference between physician practice and patient preferences is the choice of PBI modality. Although patients overwhelmingly select 3D-PBI compared with brachytherapy-PBI, physicians offer Balloon-PBI more often than 3D-PBI. Patient's rationale for their 3D-PBI choice was based on their desire to avoid the invasive procedure associated with brachytherapy. We recommend that physicians who choose to offer PBI discuss the various methods of PBI delivery.

Our work highlights several potential disconnects largely surrounding the clinical application of the new breast strategies, HF-WBI and PBI. Our intention is not to uncover factors that may lead to these disconnects, but one may speculate that referral patterns, longstanding practice habits, reimbursement potential, the allure of new technology, and other factors may contribute.

For example, considerable differences may exist in the cost between the various breast RT strategies. In a 2005 analysis of cost comparisons including CF-WBI, HF-WBI, Balloon-PBI, 3D-PBI, and other modalities, HF-WBI was found to have the lowest technical, professional and total societal cost (21) and Balloon-PBI was three times the cost of HF-WBI. Although reimbursement rates may have changed substantially since 2005, economics may continue as a factor behind the choice of breast RT strategies.

Our results also indicate marked differences in radiation practice patterns among various groups of physicians. Solo and smaller practices are less likely to employ strategies including HF-WBI, PBI, and clinical trial participation while academic and private practice groups differ considerably in their choice of PBI strategy. For example, private practice physicians were more than three times as likely to offer Balloon-PBI as academic providers, whereas academics were more than twice as likely to offer 3D-PBI.

Limitations of our series include those common to survey-based research. Our patient study cohorts do not accurately represent the US patient population. In addition, there is always responder bias, which affects both the patient and physician results. Although we spent considerable effort on instrument development, no survey tool is perfect and future refinements are possible.

To our knowledge, these are the only data describing modern breast RT practice patterns and patient preferences. Although limitations to our project exist, we believe these data firmly support the hypothesis that considerable room for improvement may be made in the employment of novel breast radiation strategies. Such concerns have even surfaced in the mainstream lay press (22). We believe the issues uncovered in this project are not unique to breast oncology and that other disciples may benefit from exploring the relationships between their practice patterns, evidence, and patient preferences.

CONCLUSIONS

We recommend that physicians, professional organizations, and health care systems formally evaluate their breast radiation practice patterns to assure that the strategies they offer are congruent with best evidence. Providers should also renew their efforts to forward patient autonomy by having meaningful discussions about treatment options. This embodies the concept of comparative effectiveness which requires careful examination of all treatment related outcomes, costs, and unintended consequences. In doing so, the clinician is better able to frame a therapeutic decision for a patient in the context of a net benefit for an intended therapy. Further research is needed to determine how to best align physician practice with available evidence and patient preference.

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