The past 40 years have brought dramatic changes in breast cancer treatments, resulting in a 30% reduction in breast cancer mortality. This is largely the result of new concepts tested in a steady stream of large, well-designed, coordinated clinical trials. Early trials showed that extended surgery (“local therapy”) does not improve mortality over less aggressive surgery. Trials conducted in the 1970s and 1980s clearly showed that radical surgery involving removal of the breast provides no outcome advantage over breast-conserving therapy (BCT). One concern with BCT has been a higher rate of local recurrence compared with mastectomy, with initial studies before the routine use of systemic therapy reporting rates of 10% to 20% with BCT. Modern series define a risk of local recurrence after BCT of 2% to 5%, about the same as with mastectomy. The improvement is partly due to improved standards in surgery, radiation oncology, and pathology. However, it is primarily due to the use of systemic endocrine and chemotherapy. BCT is appropriate for most women with breast cancer.

The 1990s

Three major advances in the 1990s changed breast surgery. The first was the acceptance of BCT by surgeons and other professionals. During the late 1980s only a small fraction of eligible women received BCT. By the late 1990s, most eligible women had BCT. Second was proof of the safety and accuracy of core needle biopsy for image-detected lesions, leading to the widespread replacement of surgical excisional biopsy. The third was proof of the hypothesis that injection of a colloidal material in the breast could map lymphatic drainage and identify the nodes most likely to harbor metastases: the sentinel lymph node biopsy (SLNB).

The Past Decade: Multidisciplinary, Accountability, Technology, and Controversy

The pace of change in breast oncology and surgery has accelerated in the past decade. Major improvements in systemic therapy with better drugs and agents directed...
at specific tumor targets (eg, trastuzumab against HER2/neu) were accompanied by a better understanding that breast cancer is a heterogeneous disease with characterization of distinct biologic subtypes. The ability to reliably characterize individual tumors with genomic profiling allows improved targeting of women with the most effective systemic therapy, and omission of systemic chemotherapy in many women who previously would have received treatment. There is every reason to expect that the pace of change and improvement will continue to accelerate with new drug targets, improved identification of prognosis, and better local therapies.

Key changes in breast surgery include systems improvement and accountability. However, technological advances that have clearly improved care, but with a limited evidence base, provide opportunity for overuse and generate controversy.

Systems Improvement

The first key advance in the past decade has been enhanced coordination of care among oncology disciplines. This has been further helped by the recognition that breast surgery is a separate medical discipline. Although breast surgical specialists do not necessarily need to practice 100% breast surgery, they must devote a major portion of work effort to breast disease to maintain competency in evolving knowledge and new techniques. This has led to a concentration of breast cancer surgery in the practices of fewer and thus busier breast surgeons. Furthermore, over the past decade, the Society of Surgical Oncology and partner organizations have increased the rigor and number of breast fellowships, creating an increasing cadre of surgeons devoted to and trained in breast disease.

Coordination and quality of care has also been the focus of surgical societies that address breast cancer. Numerous organizations have developed quality metrics and quality measurement programs for breast cancer. In addition, a program for accrediting breast centers, the National Accreditation Program for Breast Centers (NAPBC), was established in 2005 (napbc-breast.org). The NAPBC defines organizational and practice standards for breast centers and requires data submission on practices and an on-site survey with a primary focus on quality assessment and coordination of care. More than 400 NAPBC-accredited breast centers now exist.

Another key advance in the past 10 years has been the increased standardization of pathologic management of breast specimens, spearheaded by efforts of the College of American Pathology (CAP; www.cap.org/cancerprotocols). This, coupled with use of synoptic pathology reports, has markedly improved communication and coordination of care between the pathologist and other members of the breast cancer team. In addition, surgeons and pathologists now communicate more effectively regarding management of the specimen, and especially providing proper orientation of the margins, a key issue in breast cancer management that was often suboptimal.

Evolution of Margin Management: How Wide is Negative?

One area of uncertainty in breast surgery and pathologic management is the method for assessing surgical margins, and the width of normal tissue required between the cancer and margin. Although a negative margin is clearly warranted to optimize the risk of local recurrence, the extent of normal tissue needed between the margin and tumor necessary to be classified as a “negative” margin is uncertain. In addition, no consensus exists on the best surgical method and pathologic processing procedures for evaluating margins.

The original clinical trials of BCT defined a negative margin as “no ink on tumor”; in other words, any margin with at least a few cells between the inked margin and the tumor was deemed negative. Most providers attempt to get a wider margin of normal tissue. A recent survey of surgical oncologists showed that most would perform a reexcision of breast tissue to get a wider margin if the margin was less than 2 mm, and some wanted a margin greater than 5 mm.

Despite this practice variation, meta-analyses of published data fail to show any further reduction in the risk of local recurrence for any margin wider than “no ink on tumor." Efforts to obtain very wide margins may paradoxically worsen outcome for patients with a vicious cycle of more and more aggressive but unnecessary surgery. At the least, requiring a wide margin increases rates of reexcision when a margin on the initial excision is deemed too close. Concern over the potential appearance of the breast with this reexcision may lead to additional contralateral breast surgery to achieve symmetry between the breasts, and/or to an otherwise unnecessary mastectomy. In the absence of conclusive
data, this remains an area of controversy and heated debate, and one that is hard to address in controlled clinical trials.

Technological Advances and Controversies

A major change in breast surgery practice has been the use of MRI. Compared with other breast imaging, breast MRI may provide better information on the extent of a primary cancer, the presence of multifocal disease in the involved breast, and otherwise occult contralateral cancers. A seminal report in 2007 showed that MRI detects mammographically occult small contralateral cancers in 3% of women. MRI evaluation of cancer extent may allow more precise determination of the possibility of BCT with larger cancers, and of the degree of response to neoadjuvant therapy and the possibility of subsequent BCT. However, any benefit of MRI comes at the cost of a high frequency of false-positive and ambiguous findings. Positive results on MRI alone should not direct surgery. Biopsy confirmation should be obtained because of the significant chance of false-positive MRI findings. MRI may also overestimate the extent of cancer in the breast, leading to unnecessary extension of surgery and/or mastectomy.

Further complicating this issue is that no evidence shows that breast MRI provides value measured in outcomes. Every study examining MRI has failed to show any advantage measured by improvement in local recurrence, rate of developing a clinically evident contralateral cancer, or survival. Therefore, although MRI is an important addition to breast cancer evaluation, it may be overused and is not indicated in all cases. Its true role in breast cancer management is not fully defined.

Evolution of Axillary Lymph Node Staging

In the past decade, key clinical trials provided full proof of the safety and accuracy of SLNB in clinically node-negative cancer. Specifically, these showed that 1) SLNB provides accurate assessment of the axillary nodes, 2) axillary node dissection provides no outcome advantage in women with a negative sentinel lymph node, and 3) immunohistochemical evaluation of the sentinel node provides no clinically relevant prognostic information, while potentially leading to unnecessary adjuvant treatment. Uniform consensus now exists that routine immunohistochemistry of sentinel nodes should not be performed.

A seminal clinical trial reported in 2011 from the American College of Surgeons Oncology Group (ACOSOG) showed that axillary dissection is not necessary for women with 1 or 2 positive sentinel nodes treated with BCT and whole-breast radiation. This practice-changing trial will further reduce the risk of disabling effects of breast surgery. The need for axillary dissection in women with limited node involvement treated with mastectomy is unclear. However, the AMAROS study, an ongoing study being conducted in Europe, is comparing axillary radiation with axillary dissection for women with positive sentinel nodes. This study may be reported as early as 2013. If equivalent, the results may further limit the use of axillary dissection. In addition, further advances in the biologic classification of breast cancer that allow the need for systemic therapies to be determined may in the future even obviate the need for axillary node surgery at all.

Neoadjuvant Therapy

Another major change in breast surgery practice is the increased use of neoadjuvant systemic therapy. Presurgical chemotherapy and/or endocrine therapy provide similar benefits, measured by disease-free and overall survivals, compared with standard postoperative therapy. However, presurgical therapy provides distinct advantages, especially in T2 or larger tumors, for which systemic treatment will be administered regardless of node status. It often allows for BCT when mastectomy would otherwise be needed, and it provides for assessment and study of individual response to systemic therapy. Furthermore, evidence generated in the past 10 years shows that early response measured by functional imaging (eg, functional PET or MRI) and overall pathologic response provides prognostic information on the ultimate cancer outcome. Use of presurgical systemic therapy will likely increase as new targeted agents are developed, and studies evaluating the omission of surgery in women with complete imaging response may even be conducted.
Radiation: More of Less

The move to minimize therapy also extended to the study of new techniques for radiation administration. Since the 1970s, the standard technique has been whole-breast radiation administered in daily fractions over 6 weeks, with a further boost to the tumor bed. Major clinical trials in Canada recently showed that whole-breast accelerated treatment over just 3 weeks provides the same oncologic and cosmetic outcome. Investigators have further postulated that with treatment just to the area of the lumpectomy site, treatment can be administered over 5 days. This accelerated partial breast irradiation (APBI) may provide equal results for small, lower-risk cancers. Single-institution and registry studies reported to date with short follow-up show risks of local recurrence similar to those associated with whole-breast radiation. Although the results of one population-based study in older women provides a cautionary note by showing that women treated with APBI have a higher rate of subsequent mastectomy than those treated with whole-breast radiation, this rate was still very low. A national clinical trial comparing whole-breast radiation and APBI has enrolled thousands of women, but results will not be available for a few years. Despite the absence of clinical trial data, over the past 5 years the use of APBI in place of standard radiation has mushroomed in the United States. APBI is likely best used for small cancers with negative nodes. To guide providers, in 2009 the American Society for Radiation Oncology issued guidelines for cases deemed appropriate and not appropriate for APBI.

Intraoperative radiation may even further shorten the time needed for radiation to a single fraction on the day of surgery. Several techniques are being studied to deliver radiation during surgery primarily for small, low-risk cancers. One study reported in 2010 showed a limited difference in local recurrence compared with whole-breast radiation on short-term follow-up.

Another major advance in the past 10 years has been the clear demonstration that it is appropriate to omit radiation in women older than 70 years with T1, hormone receptor–positive breast cancer that are treated with lumpectomy and endocrine therapy. A clinical trial led by CALGB investigators showed no difference in overall and breast cancer–specific survival for women treated with endocrine therapy with or without breast radiation at more than 10 years’ follow-up. Local in-breast recurrence was only slightly higher in those not receiving radiation (∼6% vs. 2% with radiation), and most were readily treated with repeat lumpectomy. Despite this level I evidence and incorporation into practice guidelines, most women in this group continue to receive what may be defined as unnecessary radiation.

On the other end of the cancer spectrum, meta-analyses conducted in the past decade showed clear benefits for postmastectomy radiation in women with positive nodes, measured in reduced local recurrence and improved survival. A rule of thumb from large-scale meta-analysis is that for those with a risk of local recurrence greater than 10%, 1 death is prevented for every 4 local recurrences avoided. This has led to increased use of radiation after mastectomy for women with any number of positive nodes who carry such risk. Radiation may affect the use, specific technique, and outcome of reconstruction. Therefore, this issue should be considered in women with invasive breast cancer who are undergoing immediate breast reconstruction.

Reconstruction and Patterns
Use of Mastectomy

A major thrust of breast surgery in the past 10 years has been oncoplastic and breast reconstructive surgery—methods to improve the appearance or cosmetic results of breast surgery. Women who require mastectomy may desire reconstruction, and this can usually be performed at the time of initial surgery without compromising cancer treatment and outcome. Increased use of radiation after mastectomy for women with positive nodes, coupled with the potential impact of radiation on the reconstruction result has shifted some centers to delay reconstruction until after completion of all treatment, although no clear absolute best practice exists. New techniques for use of autologous tissue developed in the past 10 years include the use of the deep inferior epigastric perforators with abdominal wall skin and fat tissue (DIEP flap) similar to the rectus abdominis muscle flaps, but without entering the muscle fascia or taking any muscle, thus eliminating risk of abdominal wall weakness and hernia. Another technique popularized in the past decade is nipple-sparing mastectomy coupled with reconstruction. This provides improved appearance, although concern remains that preserving the nipple could increase the risk of local recurrence. It is best reserved for those with smaller tumors located well away from the nipple, or potentially those undergoing prophylactic mastectomy.
The use of plastic surgery techniques for tissue transfer and remodeling in women undergoing BCT has also been refined and broadly applied in the past 10 years. Termed oncoplastic surgery, this field has added a new dimension to the ability to preserve the breast while providing a superior cosmetic result.\textsuperscript{39} Oncoplastic techniques on the treated breast are often combined with breast cosmetic procedures on the opposite breast to provide symmetry and improved appearance.

Another new technique developed and broadly applied in the past 10 years is autologous fat grafting to recontour defects after BCT and breast reconstruction.\textsuperscript{39} This technique is increasingly used, but has not been fully studied for its safety. Some concern exists about this technique because the transferred fat contains multipotent adult stem cells that could impact cancer recurrence risk.\textsuperscript{40}

**Overuse, Underuse, Evaluating Practice, and Decision Support**

The increased number of choices and apparent conflicting evidence and opinion in breast surgery is reflected in the wide variation seen in practice. Confusion exists on the part of breast oncologists and surgeons and among women with cancer. This has led to 2 important areas of research that have become prominent in the past 2 years.

The need to evaluate quality of care and address practice variation and cost has led more surgeons and breast surgeons to participate in health services research. Efforts to understand variation in care and improve quality are imperative to improving breast cancer outcomes, and breast surgeons must be actively involved in this arena.

Significant concern exists regarding the overuse of diagnostic tests and treatment. The use of MRI, insistence on wide margins leading to more surgery, and performance of contralateral surgery to achieve symmetry are 3 possible examples. Clear evidence now shows that the rate of mastectomy that was decreasing in the early 2000s is now rising, along with the use of contralateral prophylactic mastectomy.\textsuperscript{41} This is partly because of appropriate use associated with real high risk of second primary cancers with inherited susceptibility for breast cancer. However, many breast surgeons anecdotally report women of all ages with no particular added risks requesting bilateral mastectomy for early-stage disease. The extent to which this represents appropriate use related to informed patient choice or is an example of overuse requires objective study.

Conversely, population-based assessment of the quality of care shows that many women do not receive recommended adjuvant treatments, and that significant disparities exist in health care delivery. A great deal of work has focused on breast cancer diagnostic and surgery issues. Quality measures have been established related to breast care, and work to implement measurement in breast cancer has been spearheaded by the Commission on Cancer and its National Cancer Data Base.\textsuperscript{42}

Another key area of research is in decision support. Because of the frequency of breast cancer, the breast surgical decision has been the focus of research into ways to help women make informed decisions. The past decade has seen the development of new models for informing women and of new tools to help in this process.\textsuperscript{33} Many new tools will be introduced into practice in the coming years.

**The Future**

There is no doubt that breast surgery will continue its evolution and see fundamental change. A real likelihood exists that many surgeries will no longer be necessary. Key developments to expect include highly specific profiling of breast cancer to allow treatment tailored to the prognosis and drug sensitivity of that cancer. This will result in new pharmacologic approaches with enhanced efficacy and reduced toxicity that can be administered to only those who need therapy and will benefit. Decisions regarding the need for and type of systemic therapy will be based on biologic properties of the tumor rather than anatomic extension. This, coupled with longstanding clinical trial data showing that axillary surgery does not impact survival, make it likely that the use of axillary lymph node surgery will be sharply curtailed or eliminated, especially for women with clinically negative nodes. A clinical trial proposal is already under review to test the strategy of eliminating SLNB in high-risk cancer for which chemotherapy will be used irrespective of node involvement.

The area of primary tumor ablation without surgery for small cancers is another area of active research that may come into practice in the next 10 years, the most promising of which is cryoablation. Early studies show real promise, and the next decade is likely to see studies that demonstrate efficacy and safety. Although uncer-
tainty exists regarding the extent to which this will obviate the need for surgery and in which cases radiation will be necessary, this strategy is likely to have a profound impact on breast surgery practice. Similarly, more women may be treated with primary systemic therapy. Clear data already show that surgery has no impact on survival in 1) elderly women treated with endocrine therapy, and 2) women with inflammatory cancer treated with chemotherapy and chest wall radiation. These strategies may permeate into clinical trials studying whether surgery is necessary for early-stage cancer.

Health care reform is also driving major changes in oncology and breast surgery. Organizational changes within the past decade will likely continue, with further concentration of oncology care in multidisciplinary specialty practices in centers of excellence. This move should enhance the quality and efficiency of care, and speed translation of new findings into widespread practice, but must be done carefully to assure general access to care.

Conclusions
The practice of breast surgery has evolved dramatically over the past decade. Better-trained surgeons working in multidisciplinary programs with new techniques and technologies, coupled with results of clinical trials, have markedly improved treatment. Forward-thinking surgeons will continue to drive these efforts to improve the outlook for women with breast cancer.

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