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Brigham & Women's Hospital: Using Patient Reported Outcomes to Improve Breast Cancer Care

> *Through patient-reported outcome measurement, we now have access to the patient's voice and are able to embed her preferences and outcomes into our care pathways, quality improvement efforts, and health policy decisions. But the way we collect this information from patients at academic medical centers in New York and Boston may not scale to community hospitals with limited resources and more diverse patient populations.*
>
> — Dr. Andrea PusicChief, Division of Plastic and Reconstructive Surgery, and Joseph E. Murray Professor of Surgery Brigham & Women's Hospital

Dr. Andrea Pusic, founding director of the Patient-Reported Outcomes, Value & Experience (PROVE) Center at Brigham & Women's Hospital (BWH), had just completed a 2-year project to create a new mobile phone app for post-surgical breast cancer care. The app collected patients' responses to questions about their post-surgical outcomes and experiences using BREAST-Q, a patient-reported outcomes survey instrument that she developed while an attending surgeon at Memorial Sloan Kettering. The app provided patients with immediate feedback about their progress, and access to resources customized to their recovery needs. With high patient and staff satisfaction using the app, Pusic believed this approach could be deployed more extensively to bridge current national disparities in breast cancer outcomes. Several recent studies had documented higher survival rates for patients treated at designated and specialized cancer centers than for patients treated at community hospitals.[1,2] Pusic wondered what changes might be required for the app to improve the experiences and outcomes of diverse and underserved populations.

Brigham & Women's Hospital and the Dana Farber Cancer Institute

Brigham and Women's Hospital (BWH) was a teaching affiliate of Harvard Medical School and a leading academic medical center within the Mass General Brigham health care system. It was consistently ranked by U.S. News & World Report among the top 20 hospitals in America, and recognized internationally for clinical excellence and innovation in specialties that included cardiac care, orthopedics, arthritis, cancer treatment, lung care, neurosciences, women's health, and primary care.[3] BWH scientists had performed the first successful human organ transplant, conducted the

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HBS Professor Robert S. Kaplan, Navraj S. Nagra (University of Oxford Research Fellow), and Senior Researcher Syed Shehab prepared this case. It was reviewed and approved before publication by a company designate. Funding for the development of this case was provided by Harvard Business School and not by the company. Professor Kaplan has been compensated as an advisor to health care company, Avant-garde Health. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

Physicians Heart Study, which proved that aspirin could prevent a first heart attack, and initiated the first human clinical trial using programmed nanomedicine to target cancer cells.[4] BWH ranked 2nd among academic medical centers in 2020-funding from the National Institutes of Health.[5]

The nearby Dana Farber Cancer Institute (DFCI) had been founded in 1948 by pathologist Sidney Farber to prevent and cure cancer. In 1996, BWH and DFCI formed a joint venture for collaborative treatment of adult oncology. The collaboration offered a single clinical trials system and a single interface with industry and the National Institutes of Health.[6]

In 2002, the joint venture created the Dana-Farber/Brigham and Women's Cancer Center (DF/BWCC). The center brought together medical oncologists, radiation oncologists, breast imaging specialists, breast pathologists, breast surgeons, and plastic/reconstructive surgeons for integrated, multidisciplinary cancer treatments. Under the agreement, BWH provided inpatient services and DFCI provided outpatient care.

Cancer Treatments, Cost, and Outcomes

Surgery was the mainstay treatment for the 250,000 cases of breast cancer diagnosed each year in the U.S.[7] Surgery was supplemented by chemotherapy and radiotherapy for advanced stage cancers. Chemotherapy regimens varied based on cancer stage, the tumor's genetic subtype, and patient-specific factors. The many combinations of disease stage, patient characteristics, and available treatments produced a wide range of treatment options and created the need for a multidisciplinary approach.[8] The DF/BWCC program boldly stated, "Ending women's cancers, including breast cancer, is the reason we exist."[9]

The National Cancer Institute forecast that the cost for treating cancer would increase from $183 billion in 2015 to $246 billion in 2030.[10] Expenditures for female breast cancer treatment, the largest component, had grown from $16.5 billion in 2010 to $19.70 billion in 2018 (see **Exhibit 1**).[11] The rise in costs reflected the disease's prevalence, changing treatment patterns, and multiple treatment options.

A study showed that 18% of long-term breast cancer survivors paid between $2,100 and $5,000 in out-of-pocket expenses for insurance copayments, coinsurance, deductibles for medications, hospitalizations, and outpatient services; 17% spent more than $5,000; 12% reported having medical debt four years postdiagnosis. [12,13] Racial and ethnic minority patients remained the most vulnerable to financial distress attributable to breast cancer, even after adjustment for income, education, and employment.[14]

The quality of care in oncologic surgery was measured, historically, by overall survival rates, recurrence-free survival, and progression-free survival. Several leading cancer care physicians, however, believed that patient-reported outcomes (PROs) also needed to be collected and interpreted.[a] PROs provided a broader aspect of a patient's post-treatment quality of life, particularly for a disease like breast cancer, where many patients survive the disease but struggle with the long-term effects of treatment.[15,16] Multiple randomized trials showed that different breast cancer surgery techniques and reconstruction approaches had equivalent survival outcomes but different quality-of-life outcomes. Choosing among them would require metrics beyond complications rates and disease recurrence.

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[a] PROs were any report of the status of a patient's health condition coming directly from the patient, without interpretation by the patient's clinician.

Breast Cancer Treatment at Memorial Sloan Kettering

Pusic, Canadian born, had trained in general and plastic surgery. She earned a master's degree in epidemiology and biostatistics at Johns Hopkins University where she wrote a thesis on measuring patient outcomes and experiences in breast cancer care. After a fellowship in breast reconstruction at New York's Memorial Sloan Kettering (MSK), Pusic spent several years of practice in Vancouver before returning to MSK as an attending surgeon.

In 2017, MSK opened an ambulatory cancer surgery facility at which patients undergoing cancer surgeries were discharged within 24 hours. Rapid discharges after a major surgery placed a greater burden on patients and their families during recovery. Pusic and the head of the ambulatory surgery center assembled a team of surgeons, nurses, anesthesiologists, administrators and IT specialists, along with a patient and family advisory committee, to develop MSK Recovery Tracker (see **Exhibit 2**), a stand-alone personalized portal to monitor patients at home for 10 days post-surgery. Patients entered daily data about their symptoms; nurses monitored the system and called patients with worrisome symptoms. Version 2.0 of Recovery Tracker provided patients with automatic feedback about their symptoms and pain, enabling them to self-monitor their progress. The newer version decreased the need for continuous nurse monitoring by triggering automatic alerts when patients reported adverse symptoms. The automatic feedback to patients about their symptom severity reduced patient anxiety and nurse monitoring time.[17] A retrospective study of over 7,000 patients discharged from the ambulatory facility showed that unnecessary visits to emergency departments and urgent care centers dropped by 22% for all patients, and by 42% of patients who submitted at least one report.[18]

Pusic recalled:

> MSK had a great environment for implementing Recovery Tracker. The ambulatory surgery center had a small footprint in Manhattan with a team of surgeons and nurses who worked closely together and met regularly to discuss our patients. MSK also had an expert IT group that enjoyed collaborating with the clinicians, and was very open to innovation, especially innovation that improved patients' experiences and outcomes.

Pusic's interest in the patients' perspective during and after surgery led her to ponder the gap between clinician and patient-reported outcomes:

> We measured everything through the lens of the surgeon, "Did I nick a nerve? Did I cause an infection? Did I leave some cancer cells behind?" We could measure these adverse clinical outcomes, including complications, disease recurrence, and death, consistently and rigorously. Breast reconstruction surgery, however, has a relatively low incidence of complications and does not impact cancer survival rates.
>
> In contrast, we rarely measured a patient's perspective about her reconstructive surgery outcomes, and never with rigor. A surgeon might say "you look great," and she thinks, "well, ok, if you say so," even if she didn't feel that way. Physicians considered post-treatment patient feedback on pain, physical function, and body image too subjective and "soft" to be useful. But these outcomes are important to patients and only patients can report on them. If we could solve this measurement problem, every patient would provide us with a new data point for improving patient outcomes.

Pusic and a team of international experts in psychometrics, quality of life, and social science methods conducted a three-year study to develop and validate a patient-reported outcome measure (PROM) for women who had undergone breast cancer surgery. With the help of over 2,000 women in the U.S. and Canada, they developed questions about the issues and outcomes that mattered most to patients and, after an extensive psychometric evaluation of patient responses, selected the questions with highest reliability and validity for an instrument they called the BREAST-Q (see **Exhibits 3a** and **3b**).[19] Pusic reported:

> The science of psychometrics enabled us to translate ordinal-scale subjective data from patients into accurate and reliable interval-level measurements, just like temperature and blood pressure measurements.

Patients used cell phones, on-site iPads, and email to send their BREAST-Q responses to MSK's PRO platform, where they were incorporated into personalized clinical care. The MSK team fully integrated PRO data collection into their clinical workflow, including review of results with patients, and was ultimately able to achieve an 85+% response rate.[20]

Pusic described how PROs changed the dialogue between surgeons and patients:

> Surgeons are most comfortable when telling patients what they know most about, which are technical options for the surgery and the risk of complications. Surgeons, not knowing what it feels like to be the patient, are less comfortable talking about what to expect when all goes well, which is most of the time.
>
> PROs quantify the normal experience; what patients want to know about when making decisions about their surgery. With PROs, surgeon can better communicate expected outcomes and have patients participate more fully in decision making. And this applies broadly, not just for breast cancer surgery.

MSK released the BREAST-Q for use by all institutions around the world. In 2017, ICHOM (International Consortium for Health Outcomes Measurement) included the BREAST-Q instrument in its breast cancer outcomes standard set.[21] By 2020, it had been translated into more than 40 languages and dialects, and used by over 4,000 researchers and clinicians for routine clinical care, research studies, and national quality improvement initiatives involving more than 100,000 women in 77 countries.

In a large multicenter study, encompassing 11 cancer centers and 2,000 women, Pusic and colleague at the University of Michigan compared BREAST-Q satisfaction scores when using implants for breast reconstruction versus a more time-consuming reconstruction procedure that used the patient's own tissue. Pusic noted that "hospitals preferred implant surgery because it required less time in the operating room. Before doing the study, we thought that women would also prefer the shorter operation, which apparently produced the same result." The study, however, showed that patient satisfaction was higher for own-tissue reconstruction, which, Pusic noted, we should have anticipated, "Using your own skin, with fat and blood running naturally through it, and changing over time with you, should feel better than an artificial implant."

MSK surgeons used the study to advocate for widespread use of own-tissue reconstruction and to discuss with payers about providing better coverage for this more expensive, but patient-preferred, option. MSK began offering more own-tissue reconstruction as a recommended option, a decision that enhanced its reputation as a center of excellence for microsurgical breast reconstruction.

PROVE Center at BWH

In 2018, Pusic left MSK to join BWH as Chief of Plastic and Reconstructive Surgery. Upon her arrival at BWH, Pusic noticed a gap:

> Mass General Brigham had great C-suite leadership and buy-in for the importance of patient reported outcome measurement. It had a broad program that collected hundreds of thousands of PRO data points from tens of thousands of patients, but nothing yet for breast cancer patients.

Pusic established the Patient-Reported Outcomes, Value & Experience (PROVE) Center, with a mission to expand the collection, analysis and impact of patient-reported outcomes measurement in surgery. The PROVE Center would use innovative methods to study outcomes that mattered most to patients and their caregivers. Through collaboration with clinicians, researchers, patient advocates, health informatics experts and policymakers, PROVE sought to amplify the patient's voice in research, care delivery, and decision-making.

The center's initial project created a digital platform, called imPROVE, to increase patient engagement in PRO data collection and use. The platform provided real-time feedback to patients about their symptoms and quality of life with links to tailored resources and advice about when to reach out to the clinical team. The imPROVE platform integrated clinical information on surgical treatment, chemotherapy and radiotherapy regimens with patients' BREAST-Q responses. Pusic formed a multi-stakeholder team of breast cancer patients, patient advocates, anesthesiologists, nurses, radiation oncologists, medical oncologists, and breast surgeons to inform imPROVE's design. She contracted with a Boston-based software company to create an imPROVE mobile phone app for patients to submit their responses and to access their breast cancer treatment pathway, including their providers' names, clinic dates, and treatment details (see **Exhibit 4**). They accessed the app to compare their progress and outcomes with those of other patients at the same treatment stage. Pusic noted:

> The imPROVE app empowered patients to assess and manage their recovery, especially when they experienced symptoms or had question following surgery and during treatment. It included links to resources about how to manage symptoms and advice about when to call the care team about a worrisome symptom or trend.

The imPROVE platform also integrated patient-reported outcomes with clinical data from the EHR and other hospital data bases to allow for quality improvement and outcomes research. With the success of this initial project, Pusic began to extend the mobile app approach to patients treated in other areas of surgery, such as gynecologic oncology.

Measuring Breast Cancer Treatment Costs

Pusic had asked her Chief of Surgery, upon arrival at BWH, what concerns kept him up at night? He replied:

> We're fee-for-service now but may need to change to a bundled care model for breast cancer treatments and other extended surgical programs. Can we still afford to offer excellent care under a bundled payment model? Do we have the outcomes data for such a transition?

Pusic had been educated and trained in the Canadian health care system where resources were limited and occasionally rationed. She had noticed the difference when practicing in the U.S.

> Surgeons liked being innovative and using the newest thing, even when it was more expensive and didn't always improve patient outcomes. I wanted to quantify how much extra it cost us when we used a more expensive procedure that patients preferred, such as own-tissue reconstruction.

She launched a time-driven activity-based costing (TDABC) project to determine the cost of providing high-value care for breast cancer patients.[22] TDABC required documenting all the clinical and administrative processes used to treat patients over their full cycle of care (see **Exhibit 5**).

Pusic assembled a multidisciplinary team of BWH and DFCC researchers, physicians, nurses, social workers, administrators and business managers. The project encompassed measurement of the cost of treating patients for all disease stages (0 – IV), including those with multiple comorbidities, and across all stages of care: initial treatment planning, chemotherapy, radiation therapy, surgical resection, surgical reconstruction, and psychosocial oncology and physical therapy services.

The team started by constructing the process map of a patient's initial arrival for treatment planning. It then mapped each surgical option— lumpectomy, mastectomy without reconstruction, and mastectomy with autologous or implant reconstruction —and any use of radiotherapy, chemotherapy and ancillary services (see **Exhibit 6**). The process maps included non-patient facing processes, such as discussions among clinicians, pathology services, and documentation. The team interviewed clinicians to get their best time estimates for each process step. Subsequently, the team validated the process maps and estimated times by shadowing patients undergoing treatment, and cross-checking time-stamped data in patients' electronic health records (see examples of process maps in **Exhibits 7** and **8**).

The team, not wanting to disseminate specific BWH personnel cost data, accessed public data on health care worker's average compensation to estimate personnel costs. Equipment costs were calculated as the sum of maintenance, repairs, and depreciation. Capacity costs rates, measured as dollars per minute, were calculated by dividing the cost of a resource (e.g. annual compensation for employees; annual cost of space and equipment) by the time (in minutes) the resource was available for patient care. The team included only the direct, traceable costs of personnel, drugs, consumables, equipment, and space in the cost calculations. It excluded the cost allocation of hospital overhead departments, such as human resources, finance and IT, since valid assignment of these expenses would have required a TDABC analysis of every support department in the hospital.

Real Time Location System

The breast cancer TDABC project benefited from real-time tracking data available for patients receiving chemotherapy and/or radiotherapy treatments. DFCC had recently installed a remote tracking location system (RTLS) and issued radio frequency identification (RFID) badges to clinicians, staff, and patients. The badges transmitted electronic signals that could be received by ceiling-mounted infrared sensors to detect when patients and their providers were in close proximity to each other. The sensors identified different provider types (e.g., surgical oncologist, medical oncologist, or nurse) and tracked patient and staff movement throughout clinical areas to capture times, to 3-second accuracy, for processes such as patient arrival to check-in, patient time in the examination room, chemotherapy delivery times, and physician-patient consultation time.

TDABC Results

The cost of interventions depended upon surgical complexity, length of operation, and use of implants (see **Exhibits 9** and **10**). The cancer stage was less important in predicting costs than the treatment modality selected by the patient and clinical team. A patient with stage 1 disease typically had a lumpectomy procedure followed by radiotherapy. The total treatment cost was $9,066, encompassing five medical and surgical oncology clinic appointments and reviews, five physical therapy sessions, surgery, and twenty radiotherapy treatments. A patient with triple negative stage 3 disease that required a unilateral mastectomy followed by 2-stage sub-pectoral implant reconstruction, chemotherapy, radiotherapy and psycho-oncology support cost $27,864. An identical patient who opted out of breast reconstruction cost $18,733 (see **Exhibit 11**). Surgery costs were 47% of the total for the stage-3 patient with implant reconstruction, but only 19% of the total for the stage-3 patient without post-mastectomy reconstruction.

Personnel costs were the highest component of surgical care cost, except when highly expensive drugs were used, and for mastectomies with implant reconstruction, for which the breast implant and acellular dermal matrix (ADM) was up to 60% of the total surgical cost. Variation in the cost of chemotherapy was driven by drug prices and number of cycles of treatment. Radiotherapy costs varied depending on the complexity of treatment planning (requiring more hours of MD, dosimetrist, and physicist time) and the number of fractions per course of treatment. At the same time, outpatient care such as clinics, psycho-oncology input, and physical therapy costs was driven by attendance frequency. The RTLS data gave the team insights into the difference in consult times between surgical and medical oncology treatments, and helped predict which patients would require more face-to-face time from the medical team.

After studying the data, the team noted that for a patient undergoing mastectomy and implant surgery, without radiation or chemotherapy, the cost of the two sheets of ADM was nearly 50% of the episode's entire cost. BWH breast reconstruction surgeons did some brainstorming and realized that for most surgeries, only one ADM sheets could be used to obtain the desired result, a process change that immediately cut the cost of ADMs by 50%. One of the BWH plastic surgeons and a PROVE Center Research Fellow applied for and won a grant from the Plastic Surgery Foundation to study how much PROs changed when ADMs were used in the reconstruction.

Pusic commented:

> The TDABC data gave us transparency into the costs of the processes and resources we use at BWH. As we extend the analysis to other sites, we can compare the same data across different health care settings. For me to be an effective advocate to improve healthcare value, I need good measures of both outcomes and costs.

The Association of Community Cancer Centers (ACCC) Project

The collection and use of PROs at MSK and BWH had improved patients' experiences and outcomes. Pusic now wanted to scale these capabilities to community hospitals where most cancer care in the country was delivered, especially to diverse and underserved populations. Considerable disparities existed for breast cancer care for patients in low-resource environments. Patients did not have easy access to their care team, and they often struggled to self-diagnose and interpret their post-treatment symptoms and reduced quality-of-life experiences. These problems were aggravated by low-health literacy, language barriers, cultural differences, and limited computer access.

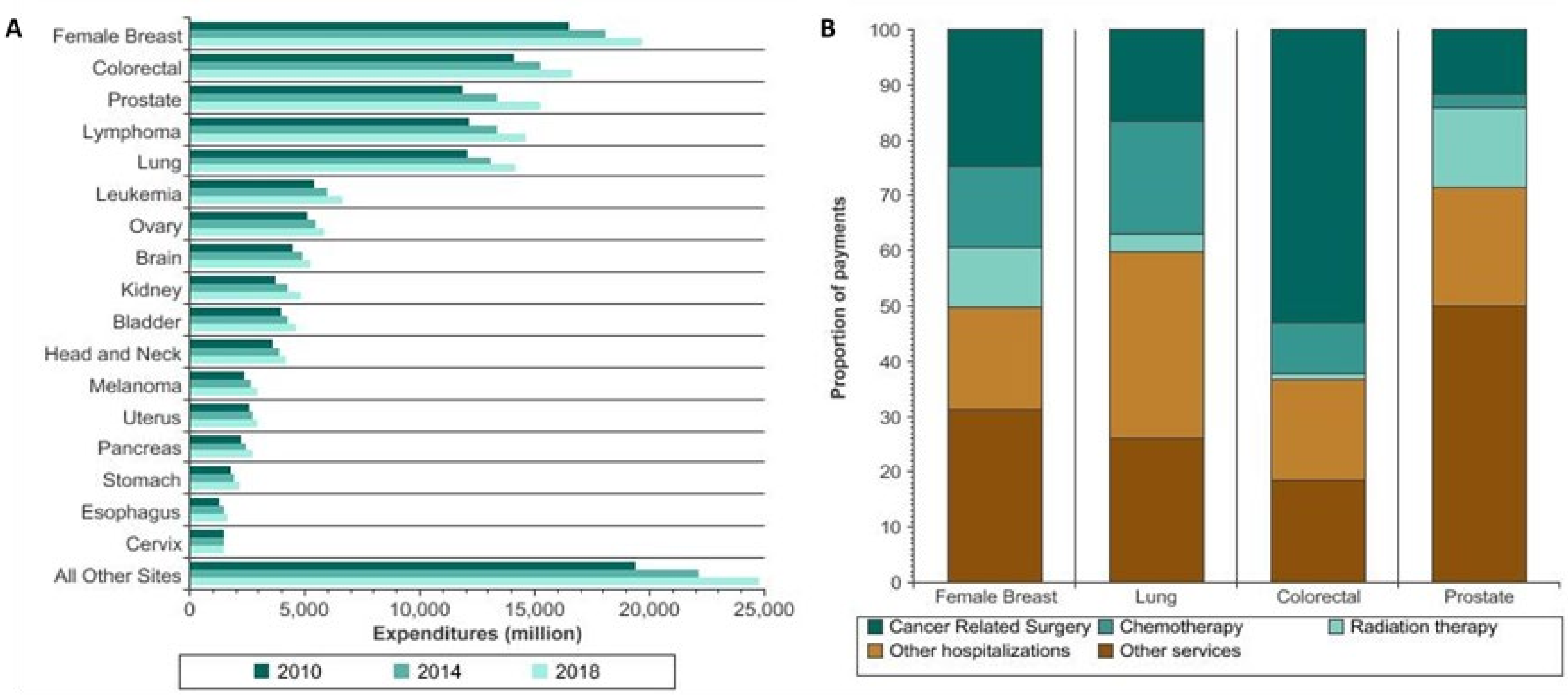
Pusic began a conversation about a pilot project with the Association of Community Cancer Centers (ACCC), a network of more than 28,000 physicians, nurses, pharmacists, administrators, and social workers employed in 2,100 cancer programs. With community health centers and providers having far fewer resources than large academic medical centers, the potential project would address the challenges for wide-spread collection of PRO data. It could reveal currently unmet needs that would inform important new clinical care and health services interventions. Pusic felt that engaging patients treated at community cancer center in PRO data collection would bring under-represented voices to quality improvement and outcomes research.

She envisioned the potential program would enlist up to two dozen ACCC centers to conduct qualitative interviews for optimizing imPROVE's design and functionality for patients and providers in low-resource settings; develop a low-burden workflow to enroll and retain patients; and identify the changes needed for BREAST-Q and imPROVE to meet the specific risks and needs of underserved patient populations.

Pusic considered whether such an extensive ACCC project was the best use of her time. Should she, instead, focus her efforts on rolling out imPROVE across the 10 Mass General Brigham hospitals that treat breast cancer?

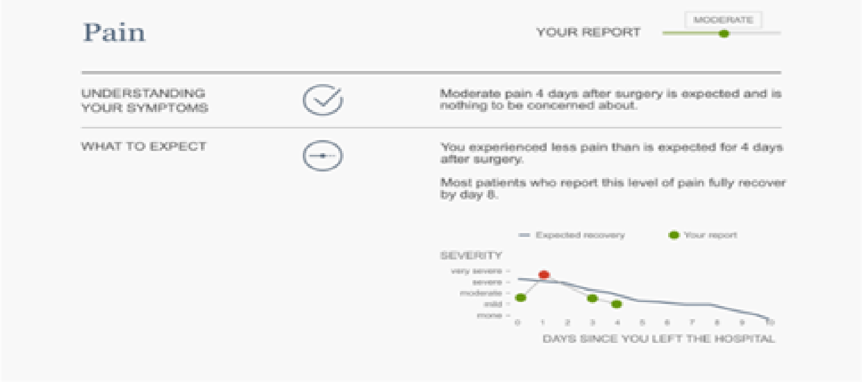
Exhibit 1 (A) Estimates of National Expenditures for Cancer Care (in millions of dollars) by Cancer Site and Year (Financial Burden of Cancer Care, 2020).

(B) Percentage of Medicare Payments in the First Year Following Diagnosis for Cancer Care by Type of Service in 2020 (Financial Burden of Cancer Care, 2020)



Source: National Cancer Institute, Cancer Trends Progress Report. https://progressreport.cancer.gov/after/economic_burden, accessed, April 2021.

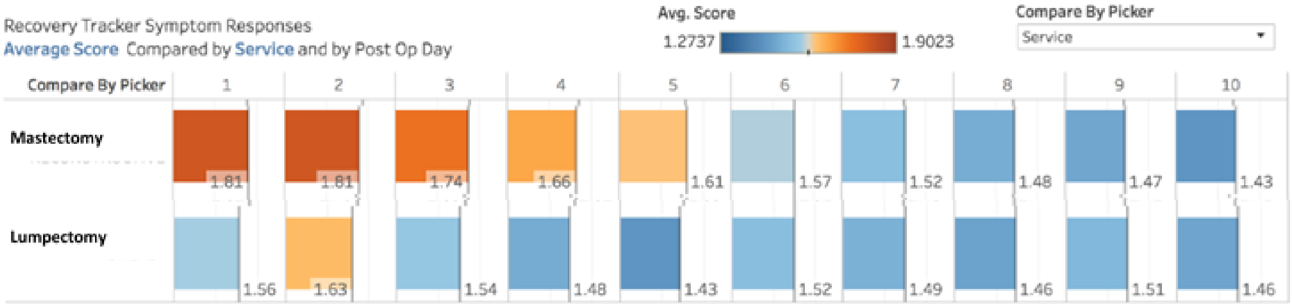
Exhibit 2 Recovery Tracker Mobile Interface (top left), Personalized Patient Report (top right), Aggregated Data for High Level Insights for Patient's Physician (middle), and Patient-Specific Progress Over Time, Used as Part of Ongoing Patient Assessment (bottom).

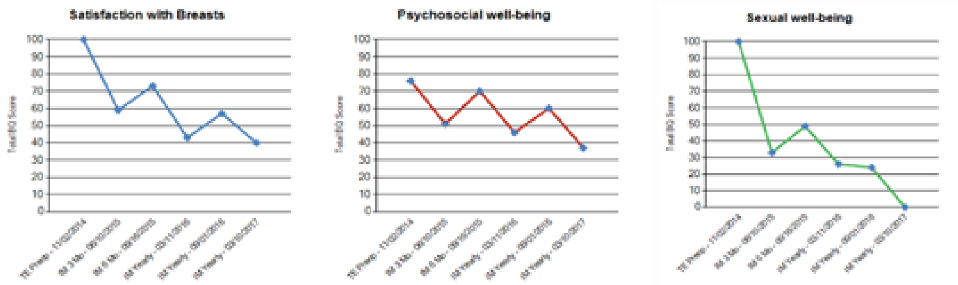


Moderate pain 4 days after surgery is expected and is nothing to be concerned about.

You experienced less pain than is expected for 4 days after surgery.

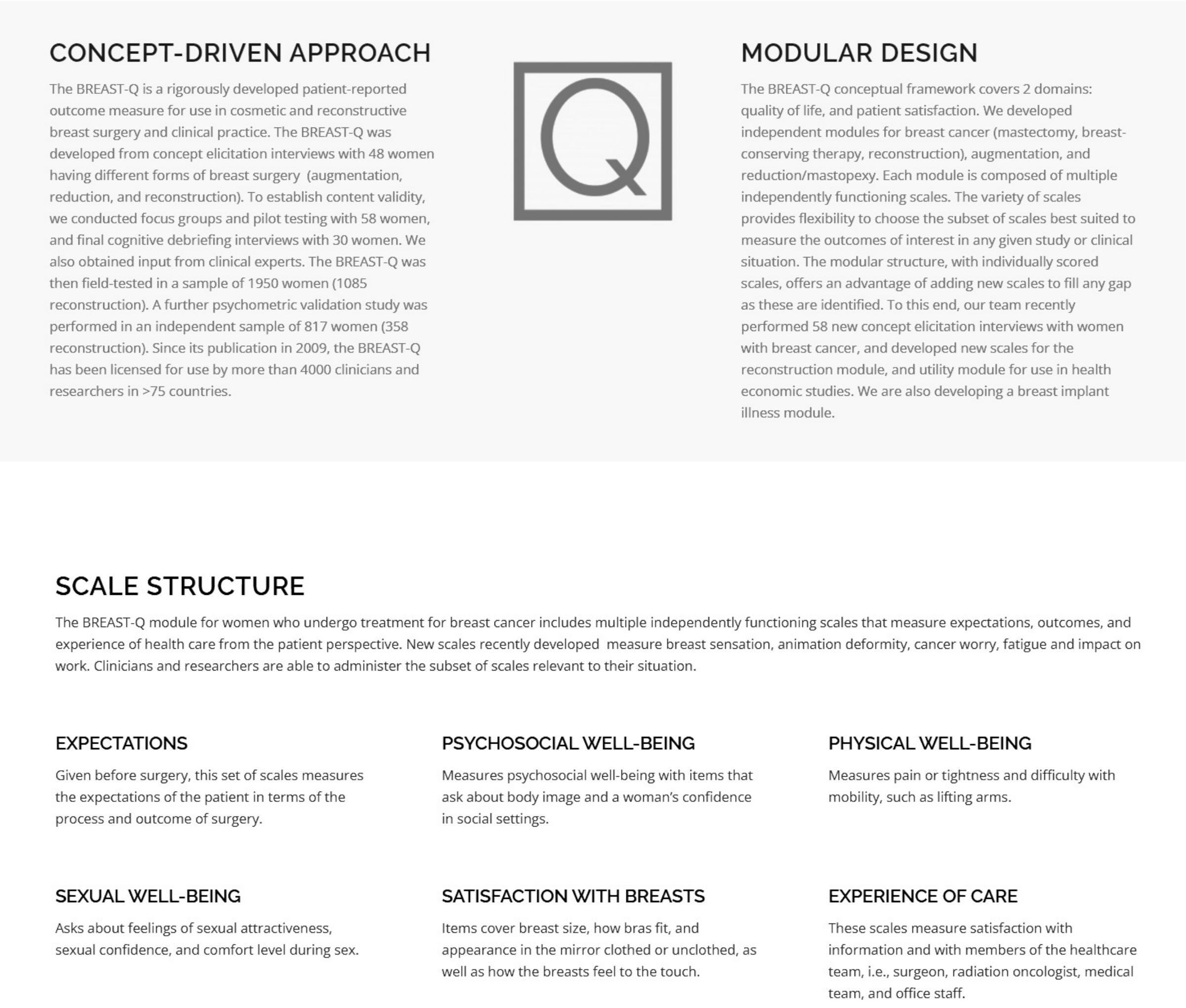
Most patients who report this level of pain fully recover by day 8.





Source: Casewriter (MyMSK app – Slide from presentation by Dr Andrea Pusic).

Exhibit 3A BREAST-Q Framework



CONCEPT-DRIVEN APPROACH

The BREAST-Q is a rigorously developed patient-reported outcome measure for use in cosmetic and reconstructive breast surgery and clinical practice. The BREAST-Q was developed from concept elicitation interviews with 48 women having different forms of breast surgery (augmentation, reduction, and reconstruction). To establish content validity, we conducted focus groups and pilot testing with 58 women, and final cognitive debriefing interviews with 30 women. We also obtained input from clinical experts. The BREAST-Q was then field-tested in a sample of 1950 women (1085 reconstruction). A further psychometric validation study was performed in an independent sample of 817 women (358 reconstruction). Since its publication in 2009, the BREAST-Q has been licensed for use by more than 4000 clinicians and researchers in >75 countries.

MODULAR DESIGN

The BREAST-Q conceptual framework covers 2 domains: quality of life, and patient satisfaction. We developed independent modules for breast cancer (mastectomy, breast-conserving therapy, reconstruction), augmentation, and reduction/mastopexy. Each module is composed of multiple independently functioning scales. The variety of scales provides flexibility to choose the subset of scales best suited to measure the outcomes of interest in any given study or clinical situation. The modular structure, with individually scored scales, offers an advantage of adding new scales to fill any gap as these are identified. To this end, our team recently performed 58 new concept elicitation interviews with women with breast cancer, and developed new scales for the reconstruction module, and utility module for use in health economic studies. We are also developing a breast implant illness module.

SCALE STRUCTURE

The BREAST-Q module for women who undergo treatment for breast cancer includes multiple independently functioning scales that measure expectations, outcomes, and experience of health care from the patient perspective. New scales recently developed measure breast sensation, animation deformity, cancer worry, fatigue and impact on work. Clinicians and researchers are able to administer the subset of scales relevant to their situation.

EXPECTATIONS

Given before surgery, this set of scales measures the expectations of the patient in terms of the process and outcome of surgery.

PSYCHOSOCIAL WELL-BEING

Measures psychosocial well-being with items that ask about body image and a woman's confidence in social settings.

PHYSICAL WELL-BEING

Measures pain or tightness and difficulty with mobility, such as lifting arms.

SEXUAL WELL-BEING

Asks about feelings of sexual attractiveness, sexual confidence, and comfort level during sex.

SATISFACTION WITH BREASTS

Items cover breast size, how bras fit, and appearance in the mirror clothed or unclothed, as well as how the breasts feel to the touch.

EXPERIENCE OF CARE

These scales measure satisfaction with information and with members of the healthcare team, i.e., surgeon, radiation oncologist, medical team, and office staff.

Source: QPortfolio. https://qportfolio.org/breast-q/breast-cancer/, accessed, April 2021.

Exhibit 3B Examples of BREAST-Q Questions

In the past week, how often have you experienced:

	None of the time	**Some of the time**	**All of the time**
Pain in the muscles of your chest?	**1**	**2**	**3**
Difficulty lifting or moving your arms?	**1**	**2**	**3**
Difficulty sleeping because of discomfort in your breast area?	**1**	**2**	**3**
Tightness in your breast area?	**1**	**2**	**3**

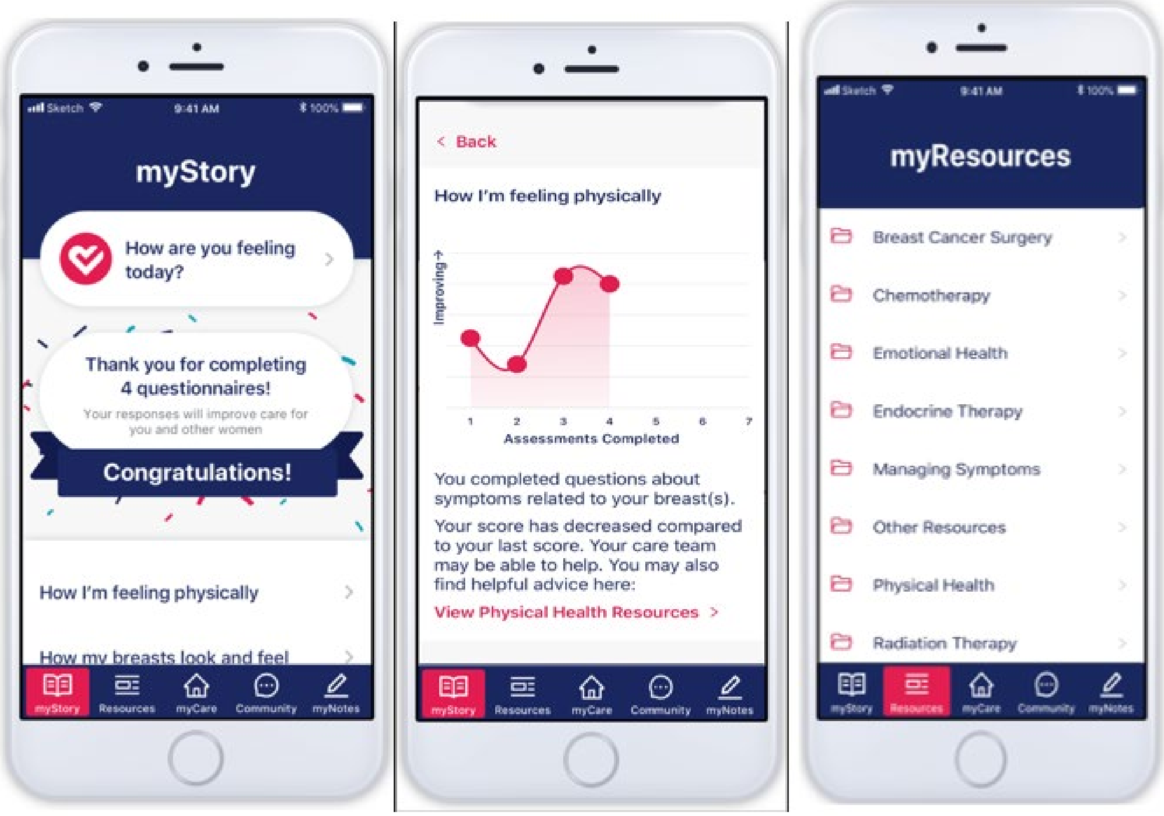
With your breasts in mind, in the past week, how satisfied or dissatisfied have you been with:

	Very Dissatisfied	**Somewhat Dissatisfied**	**Somewhat Satisfied**	**Very Satisfied**
How you look in the mirror clothed?	**1**	**2**	**3**	**4**
How normal you feel in your clothes?	**1**	**2**	**3**	**4**
Being able to wear clothing that is more fitted?	**1**	**2**	**3**	**4**
How natural your reconstructed breast(s) looks?	**1**	**2**	**3**	**4**
How your reconstructed breast(s) feels to touch?	**1**	**2**	**3**	**4**
How much your reconstructed breast(s) feels like a natural part of your body?	**1**	**2**	**3**	**4**
How closely matched (similar) your breasts are to each other?	**1**	**2**	**3**	**4**
How you look in the mirror unclothed?	**1**	**2**	**3**	**4**

Source: BREAST-Q VERSION 2.0. ©2017, Memorial Sloan Kettering Cancer Center and the University of British Columbia. All rights reserved, reproduced with permission. https://qportfolio.org/breast-q/breast-cancer/, accessed, April 2021.

BREAST-Q was authored by Drs. Andrea Pusic, Anne Klassen and Stefan Cano.

Exhibit 4 imPROVE Mobile App



Thank you for completing 4 questionnaires!

Your responses will improve care for you and other women

You completed questions about symptoms related to your breast(s).

Your score has decreased compared to your last score. Your care team may be able to help. You may also find helpful advice here:

Source: Casewriter.

Exhibit 5 Step by Step TDABC Analysis

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1. Develop process maps with the following principles:
    a. Each step reflects an activity in patient care delivery
    b. Identify the resources involved for the patient at each step
    c. Identify any supplies used for the patient at each step
2. Obtain time estimates for each process step through interviews and observations
3. Calculate the capacity cost rate (CCR) for each resource:

$$CCR\ of\ Resource\ A = \frac{Expenses\ attributable\ to\ Resouce\ A}{Practical\ capacity\ of\ Resource\ A}$$

4. Calculate the total direct costs (personnel, equipment, space, and supplies) of all the resources used over the cycle of care

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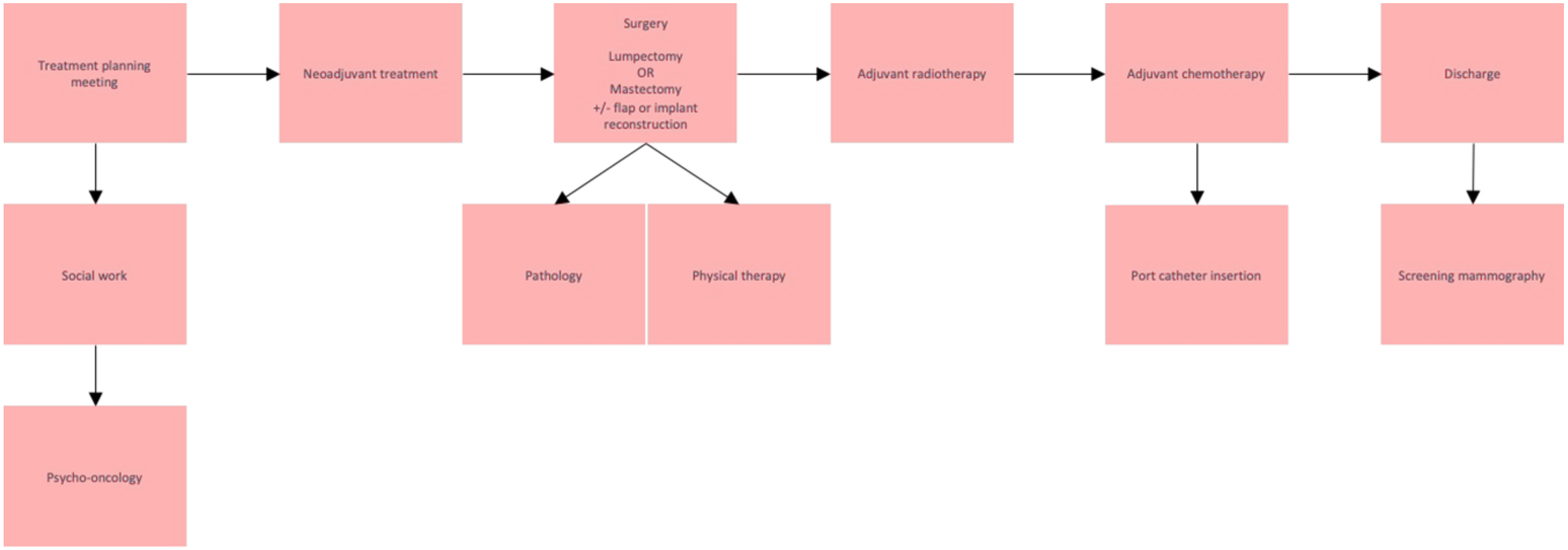
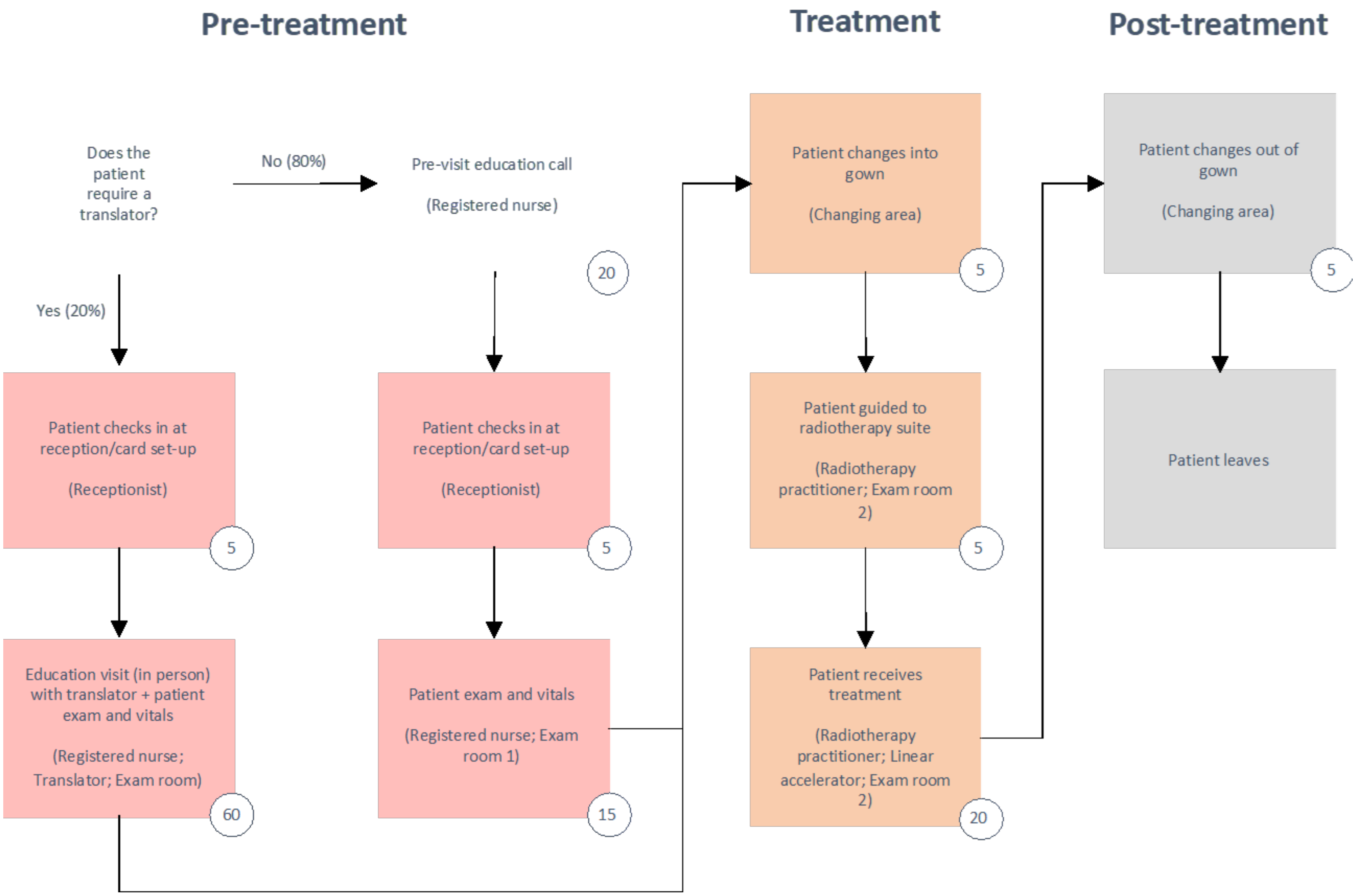
Source: Casewriter, adapted from Kaplan-Porter, "How to Solve the Cost Crisis in Health Care." (referenced in Endnote 22)

Exhibit 6 The Breast Cancer Care Cycle



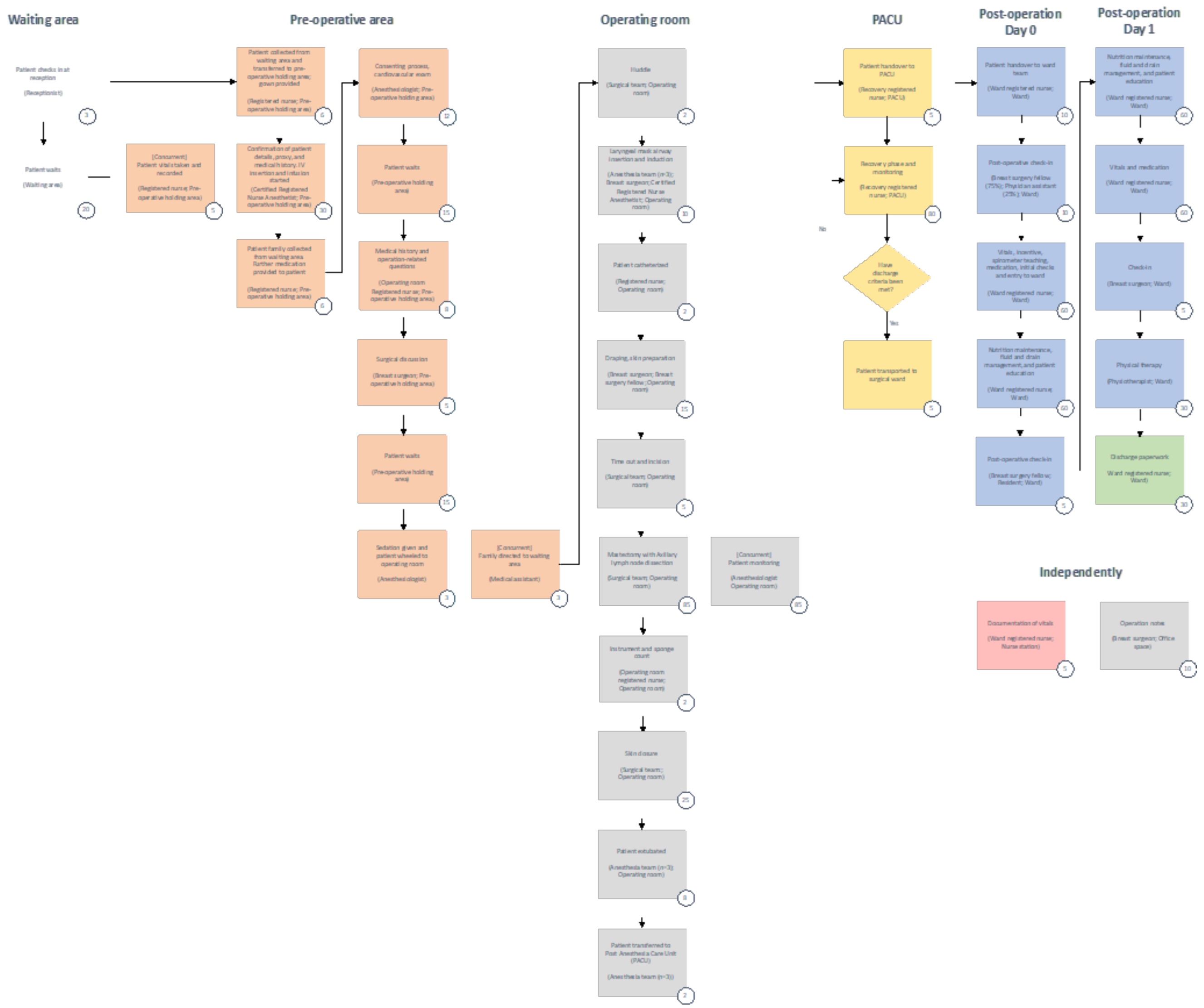
Source: Casewriter.

Exhibit 7 Radiotherapy: New Patient Session



Source: Casewriter.

Exhibit 8 Process Map for Mastectomy with no Reconstruction (Unilateral Mastectomy with Axillary Lymph Node Dissection)



Source: Casewriter.

Exhibit 9 Individual Procedure Costs

Surgical Procedures

Breast oncology appointment	$ 396
Lumpectomy	1,431
Mastectomy without reconstruction	2,945
Mastectomy with autologous reconstruction	6,275
Mastectomy with pre-pectoral implant reconstruction	14,430
Mastectomy with sub-pectoral implant reconstruction	10,773
Plastic surgery appointment	66
Pathology	243

Radiotherapy Procedures

Simulation session	$ 1,224
Patient education visit	257
Therapy visit	200

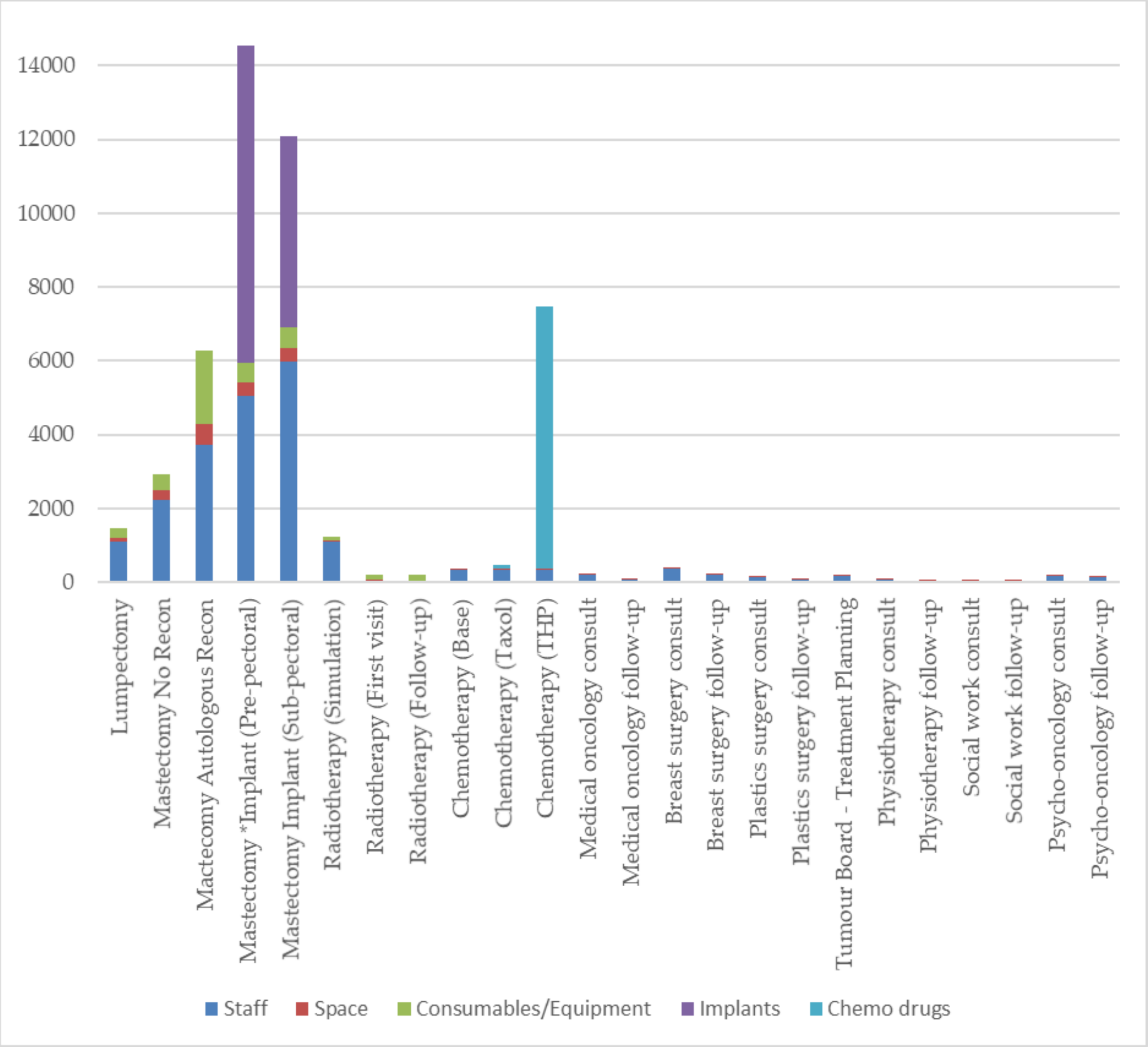
A 25-treatment cycle cost $6,050

Chemotherapy Procedures

Medical Oncology clinic appointment	$ 98
Treatment appointment	Drug cost + 382
Post-catheter insertion procedure	296

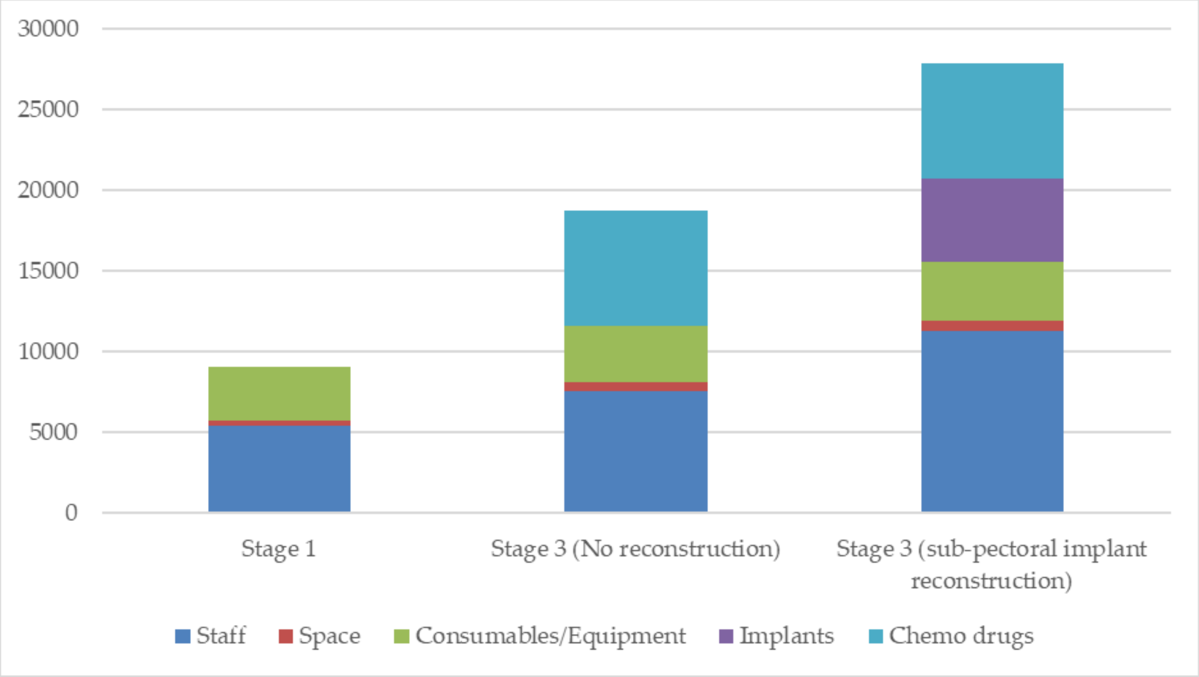
Source: Casewriter.

Exhibit 10 Surgical, Radiotherapy and Chemotherapy Costs



Source: Casewriter.

Exhibit 11 Cost of Breast Cancer Care Delivery for Patients with Stage 1 and Stage 3 Breast Cancer



Source: Casewriter.

Endnotes

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