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ORIGINAL ARTICLE – HEALTH SERVICES RESEARCH AND GLOBAL ONCOLOGY

A Systematic Review of Utility Score Assessments in the Breast Surgery Cost-Analysis Literature

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ABSTRACT

Background. Surgery for breast cancer can have significant impact on patient quality-of-life. Cost-utility analysis provides a way to analyze the economic impact of a surgical procedure with the change in a patient's quality of life. Utility scores are used in these analyses to quantify the impact on quality of life. We undertook a systematic review of the literature on breast cancer surgical procedures to compile a repository of utility scores and to assess gaps in the current literature.

Methods. Following PRISMA guidelines, a systematic review was performed for studies reporting utility scores for breast surgery and breast reconstruction. The health states and utility scores were extracted and grouped into seven procedural categories based on oncologic and reconstructive methods. Mean utility score and ranges were calculated and reported for each procedural category.

Results. Nineteen articles met the inclusion criteria assessing 118 health states. Most utility scores were obtained from healthcare professionals. Breast-conserving therapy yielded the highest mean utility score at 0.79, whereas mastectomy yielded a mean utility score of 0.75. Among reconstruction health states, implant reconstruction had a lower score than autologous reconstruction (0.64 implant vs. latissimus dorsi 0.69 and TRAM/DIEP 0.71). No utility scores were found associated with oncoplasty or nipple-sparing mastectomy procedures.

Conclusions. A reliable body of utility scores is important in enabling future cost-utility and value-based analysis comparisons for breast surgical oncology. Additional work is needed to obtain health state assessments from the patient perspective, as well as assessment of more modern surgical and reconstructive approaches.

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Breast cancer is the most common malignancy affecting about 124 per 100,000 women and is the second-leading cause of death among women in the United States.[1] Breast surgery has a significant impact on quality of life, affecting one's body image as well as one's mental and physical well-being.[2] Negative perceptions of one's body and the loss of one's sense of femininity following surgery has resulted in documented levels of both anxiety and depression.[3,4] Reconstructive surgery, which aims to mitigate the stigma of breast surgery by restoring the natural appearance of the breast, has been shown to improve patient experience, quality of life, and psychosocial outcomes.[5–8]

While surgical treatments for breast cancer provide clinical benefits, they come at a significant economic burden. With the costs of breast cancer treatment estimated at $16.5 billion annually, investigating the costs of the various types of breast cancer surgery and reconstruction is vital for optimizing patient outcomes and healthcare expenses.[9] These investigations have taken the form of economic evaluations, which have become increasingly more common in medical literature.[10–13] Cost-utility analysis (CUA), a type of economic analysis, is a cost-effectiveness assessment that measures quality-adjusted life years (QALYs), which is metric for both quality and quantity of life. Quality of life is determined by a patient's preference towards a given health state or clinical outcome.

This is measured by a utility score, in which patients rate their preference for a given health state on a scale of 0–1, where 0 equals death and 1 equals perfect life.[14]

QALYs in CUAs provide a common unit of measurement that allows one to compare the value and clinical effectiveness of different medical interventions, which each have their own unique utility scores based on how they influence a health outcome or state. By providing evidence that one approach is better than other competing alternatives, QALYs are critically important for guiding evidence-based practices and for determining whether an intervention is cost-effective. Therefore, they are often taken into consideration within healthcare policy, resource allocation, and reimbursement.[15–19]

CUA is a particularly valuable tool in evaluating breast surgical options. Because costs and prevalence are high, there are competing surgical options and varying impacts on the quality of life depending on the surgical option chosen.[10,19] To date, there is limited CUA literature specifically examining the utility of breast surgery as an element of breast cancer care. In this analysis, we critically reviewed the cost-effectiveness/utility literature to collect and create a repository of utility scores related to breast cancer to serve as a resource for future analyses to assess their methodological quality and to understand potential gaps in the current research.[9,10]

METHODS

Following PRISMA guidelines for reporting systematic reviews, we performed a systematic online literature search for all studies reporting utility scores for breast surgery and breast reconstruction in MEDLINE and Cochrane Review from 1982 to 2017. Keywords included: *breast cancer, breast reconstruction, breast surgery, utility, cost-utility analysis,* and *quality-adjusted life years*. Articles met inclusion criteria if (1) utility scores were presented and (2) the utility scores were capable of being used to calculate a QALY. We excluded reviews, protocols, editorials, articles where utility scores were not presented, articles presenting scores incapable of forming QALYs, and articles written in languages other than English. Articles matching inclusion criteria were screened for any relevant publications in their reference section.

Initially 299 articles were identified, of which 19 were used (Fig. 1).[11–13,20–35] Abstracts of the 299 articles were screened. After excluding ineligible publications, 67 articles underwent full-text assessment by two independent reviewers (AJS, AYY). After full-text assessment, 16 articles matched criteria. References from these articles were examined to identify any additional articles; 3 were identified to yield a total of 19 articles. Each reviewer independently assessed each article and abstracted the health state, the associated utility score, utility score assessment tool (instrumentation), and the population surveyed. The reviewers compared the results of the data abstraction, whereas discrepancies were mediated by a third reviewer (LMB).

Health states and the corresponding utility scores are outlined in Table 1. If multiple scores existed for the same health state, the mean score was calculated. The health states and corresponding utility scores were grouped into seven procedural categories based on oncologic and reconstructive methods (Table 1). The categories are (1) breast cancer (general), (2) breast-conserving therapy, (3) mastectomy, (4) implant reconstruction, (5) latissimus dorsi implant, (6) TRAM/DIEP, and (7) autologous reconstruction.

RESULTS

Nineteen articles from 8 countries published from 1991 to 2017 met the search criteria describing 118 unique health states.[11–13,20–35] For each health state, the corresponding mean utility score, the source for the utility scores, and instrumentation for utility scores are outlined in Table 1. Based on these health state categories, listed above, the utility scores within the breast-conserving therapy (BCT) category yielded the highest mean utility score at 0.79, whereas the utility scores within the breast cancer category had the lowest mean utility score at 0.53 (Table 2; Fig. 2).

Table 3 outlines the characteristics of the included articles along with the instruments used in obtaining utility scores. Health state assessments were most often made by plastic reconstructive surgeons (38%, $n = 7$) and clinicians or health professionals (12%, $n = 2$) compared with patients (17%, $n = 3$) or the general public (33%, $n = 6$). Studies often employed more than one assessment tool to determine health utilities, but the visual analog scale (VAS) was the most common ($n = 13$), followed by time trade off ($n = 6$), and standard gamble ($n = 3$). The United States produced the most articles ($n = 6$), followed by Canada ($n = 3$), the Netherlands ($n = 3$), the United Kingdom ($n = 2$), and South Korea ($n = 2$) among others. Most of the articles were published in the *Plastic and Reconstructive Surgery* journal ($n = 5$) and the *International Journal of Cancer* ($n = 2$).[11–13,20–35]

There were three distinct health states reported within the breast cancer general category. The health states within this category consisted of those where surgical treatment was not conducted and health states in which the procedure was not properly defined.

TABLE 1 Consolidated health states and mean utility scores

Health state	Sources	Instrument	Mean utility score
Breast cancer, general[20,22,25,27,29]			
No treatment (breast cancer health state)	118 patients	SG, VAS, HaLEX	0.19
Initial or primary surgical treatment	54 health professionals	VAS	0.869
Invasive breast cancer with surgery (mastectomy or breast-conserving surgery), radiation therapy, and/or chemotherapy (AJCC 7th I, II)	509 participants interviewed by 54 interviewers	VAS, SG	0.655
Breast-conserving therapy (BCT)[20,24–28,31,32]			
Lumpectomy and radiation	162 patients	SG, VAS	0.74
Breast conserving surgery (BCT)	524 patients, 37 women, 27 clinicians or public health experts	VAS, EQ-5D-3L, EORTC tariff	0.91
Breast conserving therapy (consisting of lumpectomy with SLNB and whole breast radiotherapy)	121 women	VAS, TTO	0.85
Lumpectomy [good physical, good mental]	General population	TTO	0.8
Breast conserving surgery with radiotherapy—at baseline	102 patients	EQ-5D score	0.77
Breast conserving surgery with radiotherapy—at 3.5 months	102 patients	EQ-5D score	0.78
Breast conserving surgery with radiotherapy—at 9 months	102 patients	EQ-5D score	0.76
Breast conserving surgery with radiotherapy—at 15 months	102 patients	EQ-5D score	0.74
Breast conserving surgery without radiotherapy—at baseline	102 patients	EQ-5D score	0.74
Breast conserving surgery without radiotherapy—at 3.5 months	102 patients	EQ-5D score	0.76
Breast conserving surgery without radiotherapy—at 9 months	102 patients	EQ-5D score	0.72
Breast conserving surgery without radiotherapy—at 15 months	102 patients	EQ-5D score	0.73
Noninvasive breast cancer with breast-conserving surgery and radiation therapy (AJCC 7th 0)	509 participants interviewed by 54 interviewers	VAS, SG	0.72
Mastectomy[20,22–24,26–29,33]			
Double mastectomy and chemotherapy	162 patients	VAS, SG	0.61
Mastectomy	303 patients, 62 women	EQ-5D-3L, EORTC tariff	0.88
Absent breast	463 affected (NHIS data)	HALex	0.7
Bilateral mastectomy defect	120 participants (McGill University medical students and general population)	VAS, SG, TTO	0.81
Mastectomy for local recurrence (0–2 months after surgery)	8 health professionals	VAS	0.6
Mastectomy and radiotherapy for local recurrence (0–2 months after surgery + radiotherapy)	8 health professionals	VAS	0.587
Mastectomy—[good physical, good mental]	General population	TTO	0.77
Noninvasive breast cancer with mastectomy only (AJCC 7th 0)	509 participants interviewed by 54 interviewers	VAS, SG	0.73
Noninvasive breast cancer with mastectomy and followed by reconstruction (AJCC 7th 0)	509 participants interviewed by 54 interviewers	VAS, SG	0.74
Locally advanced breast cancer with radical mastectomy and radiation therapy (AJCC 7th IIIA, IIIB)	509 participants interviewed by 54 interviewers	VAS, SG	0.52
Mastectomy—do-nothing without radiation	9 attending plastic surgeons	VAS	0.68
Mastectomy—do-nothing with radiation	9 attending plastic surgeons	VAS	0.63
Mastectomy (with sentinel lymph node biopsy (SLNB))	121 women	VAS, TTO	0.85
Implant reconstruction[12,13,23,28]			
Immediate breast reconstruction—no complications	19 plastic surgeons	VAS, TTO	0.74
Immediate breast reconstruction—major infection	19 plastic surgeons	VAS, TTO	0.64
Immediate breast reconstruction—minor infection	19 plastic surgeons	VAS, TTO	0.71

TABLE 1 continued

Health state	Sources	Instrument	Mean utility score
Single-stage, implant-based immediate breast reconstruction without radiation: mastectomy skin necrosis	10 plastic surgeons in northeastern United States	VAS, TTO	0.67
Single-stage, implant-based immediate breast reconstruction without radiation: explantation	10 plastic surgeons in northeastern United States	VAS, TTO	0.655
Single-stage, implant-based immediate breast reconstruction without radiation: seroma	10 plastic surgeons in northeastern United States	VAS, TTO	0.69
Single-stage, implant-based immediate breast reconstruction without radiation: hematoma	10 plastic surgeons in northeastern United States	VAS, TTO	0.69
Mastectomy—immediate implant without radiation—complication—other	9 attending plastic surgeons	VAS	0.69
Mastectomy—immediate implant without radiation—complication—death	9 attending plastic surgeons	VAS	0
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ ADM): successful surgery	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.7
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ ADM): major infection	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.57
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ ADM): minor infection	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.64
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ADM): mastectomy skin necrosis	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.614
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ ADM): explantation	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.585
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ADM): seroma	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.648
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ADM): hematoma	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.636
Two-stage, expander-implant immediate breast reconstruction following mastectomy (+ADM): capsular contracture (Baker III/IV)	5 plastic and reconstructive surgeons at Dartmouth Hitchcock Medical Center	VAS, TTO	0.592
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): successful surgery	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.66
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): major infection	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.57
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): minor infection	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.62
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): mastectomy skin necrosis	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.6
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): explantation	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.585
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): seroma	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.61
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): hematoma	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.61
Two-stage, expander-implant immediate breast reconstruction following mastectomy (non-ADM): capsular contracture (Baker III/IV)	10 plastic and reconstructive surgeons in the northeastern United States	VAS, TTO	0.6
Expander-implant without radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.71
Expander-implant without radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.66
Expander-implant without radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Expander-implant without radiation (post-mastectomy)—complication—major infection	9 attending plastic surgeons	VAS	0.62

TABLE 1 continued

Health state	Sources	Instrument	Mean utility score
Expander-implant without radiation (post-mastectomy)—complication—minor infection	9 attending plastic surgeons	VAS	0.67
Expander-implant with radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.66
Expander-implant with radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.61
Expander-implant with radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Expander-implant with radiation (post-mastectomy)—complication—major infection	9 attending plastic surgeons	VAS	0.57
Expander-implant with radiation (post-mastectomy)—complication—minor infection	9 attending plastic surgeons	VAS	0.62
Immediate implant with radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.69
Immediate implant with radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.64
Immediate implant with radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Immediate implant with radiation (post-mastectomy)—complication—major infection	9 attending plastic surgeons	VAS	0.59
Immediate implant with radiation (post-mastectomy)—complication—minor infection	9 attending plastic surgeons	VAS	0.66
Mastectomy-Reconstruction (mastectomy followed by direct implant-based reconstruction and SLNB)	121 women	VAS	0.7
Latissimus dorsi implant[23]			
Latissimus dorsi implant without radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.74
Latissimus dorsi implant without radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.68
Latissimus dorsi implant without radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Latissimus dorsi implant without radiation (post-mastectomy)—complication—major infection	9 attending plastic surgeons	VAS	0.64
Latissimus dorsi implant without radiation (post-mastectomy)—complication—minor infection	9 attending plastic surgeons	VAS	0.72
Latissimus dorsi implant with radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.72
Latissimus dorsi implant with radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.66
Latissimus dorsi implant with radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Latissimus dorsi implant with radiation (post-mastectomy)—complication—major infection	9 attending plastic surgeons	VAS	0.7
Latissimus dorsi implant with radiation (post-mastectomy)—complication—minor infection	9 attending plastic surgeons	VAS	0.62
TRAM/DIEP[11,21,23,34,35]			
Abdominal hernia/bulge/weakness from TRAM flap and/or DIEP flap reconstruction surgery	75 plastic surgeons/reconstructive surgical experts	VAS	0.68
Tree TRAM/unipedicled TRAM flap—Breast Reconstruction—Hernia—Repair	33 plastic surgeons	VAS	0.65
Successful TRAM flap and or DIEP flap surgery without complications	94 plastic surgeons	VAS, TTO	0.86

TABLE 1 continued

Health state	Sources	Instrument	Mean utility score
Free TRAM flap and DIEP flap in postmastectomy reconstruction—Total flap failure	51 plastic surgeons	VAS, TTO	0.56
Free TRAM/unipedicled TRAM flap—breast reconstruction—total flap loss—debridement	33 plastic surgeons	VAS	0.53
Free TRAM flap and DIEP flap in postmastectomy reconstruction—partial flap loss or skin necrosis	84 plastic surgeons	VAS, TTO	0.72
Free TRAM flap and DIEP flap in postmastectomy reconstruction—fat necrosis [+ SIEP]	32 plastic surgeons across Canada	VAS	0.74
Free TRAM/unipedicled TRAM flap—breast reconstruction—fat necrosis—resolves Spontaneously	33 plastic surgeons (7 of 10 provinces included)	VAS	0.74
Free TRAM/unipedicled TRAM flap—breast reconstruction—fat necrosis—drainage/resection	33 plastic surgeons (7 of 10 provinces included)	VAS	0.69
Free TRAM flap and DIEP flap in postmastectomy reconstruction—hematoma [+ SIEP]	32 plastic surgeons across Canada	VAS	0.77
Free TRAM/unipedicled TRAM flap—breast reconstruction—hematoma—drainage	33 plastic surgeons (7 of 10 provinces included)	VAS	0.77
Free TRAM/unipedicled TRAM flap—breast reconstruction—hematoma—no drainage	33 plastic surgeons (7 of 10 provinces included)	VAS	0.79
Free TRAM/Unipedicled TRAM flap—breast reconstruction—infection—admission (antibiotic)	33 plastic surgeons (7 of 10 provinces included)	VAS	0.76
Free TRAM/Unipedicled TRAM flap—breast reconstruction—infection—admission (drainage)	33 plastic surgeons (7 of 10 provinces included)	VAS	0.73
Autologous reconstruction[11,23]			
Free autologous breast reconstruction: partial flap necrosis/fat necrosis	10 plastic surgeons (in the Northeast)	VAS, TTO	0.77
Autologous flap with free tissue post-mastectomy without radiation—complication—infection	19 plastic surgeons	VAS, TTO	0.75
Free autologous breast reconstruction—seroma	10 plastic surgeons (in the Northeast)	VAS, TTO	0.77
Autologous flap with free tissue without radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.79
Autologous flap with free tissue without radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Autologous flap with free tissue with radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.83
Autologous flap with free tissue with radiation (post-mastectomy)—complication—total flap loss	9 attending plastic surgeons	VAS	0.51
Autologous flap with free tissue with radiation (post-mastectomy)—complication—partial flap necrosis	9 attending plastic surgeons	VAS	0.75
Autologous flap with free tissue with radiation (post-mastectomy)—complication—infection	9 attending plastic surgeons	VAS	0.73
Autologous flap with free tissue with radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.77
Autologous flap with free tissue with radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Autologous flap with pedicled tissue with radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.81
Autologous flap with pedicled tissue with radiation (post-mastectomy)—complication—total flap loss	9 attending plastic surgeons	VAS	0.56
Autologous flap with pedicled tissue with radiation (post-mastectomy)—complication—partial flap necrosis	9 attending plastic surgeons	VAS	0.72

TABLE 1 continued

Health state	Sources	Instrument	Mean utility score
Autologous flap with pedicled tissue with radiation (post-mastectomy)—complication—infection	9 attending plastic surgeons	VAS	0.73
Autologous flap with pedicled tissue with radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.73
Autologous flap with pedicled tissue with radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Autologous flap with pedicled tissue without radiation (post-mastectomy)—no complication	9 attending plastic surgeons	VAS	0.83
Mastectomy—autologous flap with pedicled tissue without radiation—complication—total flap loss	9 attending plastic surgeons	VAS	0.58
Autologous flap with pedicled tissue without radiation (post-mastectomy)—complication—partial flap necrosis	9 attending plastic surgeons	VAS	0.74
Autologous flap with pedicled tissue without radiation (post-mastectomy)—complication—infection	9 attending plastic surgeons	VAS	0.72
Autologous flap with pedicled tissue without radiation (post-mastectomy)—complication—other	9 attending plastic surgeons	VAS	0.75
Autologous flap with pedicled tissue without radiation (post-mastectomy)—complication—death	9 attending plastic surgeons	VAS	0
Free autologous breast reconstruction—hematoma	10 plastic surgeons (in the Northeast)	VAS, TTO	0.77

Health states for BCT were reported in eight articles. Lumpectomy was the core component in defining BCT, with variations with respect to postoperative radiation therapy and sentinel lymph node biopsy (SLNB). Eighty-one (81%) of reported health states explicitly defined radiation therapy as a component of BCT. There were no health states found related to complications, oncoplastic surgery, postradiation changes, or asymmetry following BCT.

Thirteen distinct health states for mastectomy were reported in ten articles.[20,22–24,26–29,33] Health states within this category included mastectomy without reconstruction, absent breast, bilateral/double mastectomy, mastectomy for local recurrence, and mastectomy for noninvasive breast cancer. None of the reported health states differentiated the type of mastectomy performed. Specifically, the utility of a nipple-sparing mastectomy has not been assessed.

There were 41 distinct health states reported from 4 articles for the implant reconstruction category.[12,13,23,28] Implant reconstruction entailed immediate breast reconstruction and staged reconstruction procedures with and without radiation after mastectomy, alongside post-procedural complication health states. There were no utility scores reported for prepectoral placement of implants post-mastectomy.

There are ten distinct health states in the latissimus dorsi flap implant reconstruction category, all from a single source.[23] Therefore, comparison of utility scores for latissimus dorsi reconstruction health states across different studies were not assessed.

Within the TRAM/DIEP reconstruction category, 14 distinct health states were reported throughout 4 articles.[11,21,23,34,35] Postoperative complication health states included, abdominal hernia/bulge/weakness, hernia repair, total flap failure, total flap loss requiring debridement, partial flap loss, skin necrosis, fat necrosis that either resolved spontaneously or required drainage/resection, hematoma with or without subsequent drainage requirement, and infection that either underwent antibiotic treatment with or without drainage. TRAM/DIEP reconstructive surgery without complications yielded a mean utility score of 0.86. Total flap failure requiring debridement yielded the lowest mean utility score of 0.53, whereas partial flap loss yielded a mean utility score of 0.72.

There were 24 distinct health states from 2 articles for the autologous reconstruction category, which included health states for autologous free flap post-mastectomy and autologous pedicled flap post-mastectomy, with or without radiation.[11,23] Infection, partial flap necrosis, and total flap loss were common post-procedural complications encountered with autologous reconstruction. Partial flap necrosis yielded a higher mean utility score of 0.74 compared with total flap loss, which had the lowest mean utility score of 0.55.[11,23] Infections yielded a mean utility score of 0.73.[11,23]

TABLE 2 Health state categories

Health state category	Utility score range (Δ)	Mean utility score
Breast cancer, general[20,25,27,29]	0.17–0.87 (0.70)	0.53
Breast conserving therapy (BCT)[20,24–28,31,32]	0.66–0.93 (0.27)	0.79
Mastectomy[20,22–24,26–29,33]	0.44–0.96 (0.52)	0.76
Implant reconstruction[12,13,23,28]	0.57–0.74 (0.17)	0.64
Latissimus dorsi implant[23]	0.62–0.74 (0.12)	0.69
TRAM/DIEP[11,21,23,34,35]	0.44–0.87 (0.43)	0.71
Autologous reconstruction[11,23]	0.51–0.83 (0.32)	0.73

TRAM transverse rectus abdominus myocutaneous, *DIEP* deep inferior epigastric perforator

TABLE 3 Article characteristics

Article[11–13,20–35]	Year	Journal of publication	Country	Source	Instrument
Kim et al.	2017	Patient Preference and Adherence	South Korea	General Public	VAS
Knuttel et al.	2017	Value Health	Netherlands	General Public and Patients	TTO, VAS
Chatterjee et al.	2015	Plastic and Reconstructive Surgery	United States	Reconstructive Surgeons	VAS
Kim et al.	2015	Health and Quality of Life Outcomes	South Korea	Patients	EQ-5D-3L
Krishnan et al.	2014	Journal of Plastic, Reconstructive & Aesthetic Surgery	United States	Plastic and Reconstructive Surgeons	TTO, VAS
Krishnan et al.	2013	Plastic and Reconstructive Surgery	United States	Plastic and Reconstructive Surgeons	TTO, VAS
Chatterjee et al.	2013	Plastic and Reconstructive Surgery	United States	Plastic and Reconstructive Surgeons	TTO, VAS
Grover et al.	2013	Plastic and Reconstructive Surgery	United States	Plastic and Reconstructive Surgeons	VAS
Sinno et al.	2013	Breast	Canada	General Public and Medical Students	TTO, VAS, SG
Prescott et al.	2007	Health Technology Assessment	United Kingdom	Patients	EQ-5D score
Mansel et al.	2007	British Journal of Cancer	United Kingdom	Patients	Chained SG
Thoma et al.	2004	Plastic and Reconstructive Surgery	Canada	Plastic and Reconstructive Surgeons	VAS
Thoma et al.	2003	Microsurgery	Canada	Plastic and Reconstructive Surgeons	VAS
Cappelli et al.	2001	Quality of Life Research	Canada	General Public and Patients	VAS, SG
Gold et al.	1998	Medical Care	United States	Patients	HALex
Norum et al.	1997	Breast Cancer Research and Treatment	Norway	General Public	EORTC Tariff
Liljegren et al.	1997	Annals of Oncology	Sweden	Health Professionals	VAS
Hall et al.	1992	Social Science & Medicine	Australia	General Public	TTO
de Koning et al.	1991	International Journal of Cancer	Netherlands	Public Health Experts and Clinicians	VAS

DISCUSSION

Implications Regarding Utility Scores

As health care transitions toward surgeon evaluation using quality measures, patient-reported outcomes, and value-based metrics, it is essential for breast surgeons to understand clinical outcomes represented by utility scores to become an active participant in this time of change. Such knowledge can empower a surgeon to justify the value of a surgical approach at a local level or produce value analysis research that can impact health care reimbursement on a national level. Past utility score assessment in oncology have provided little data specific to breast surgery, and this

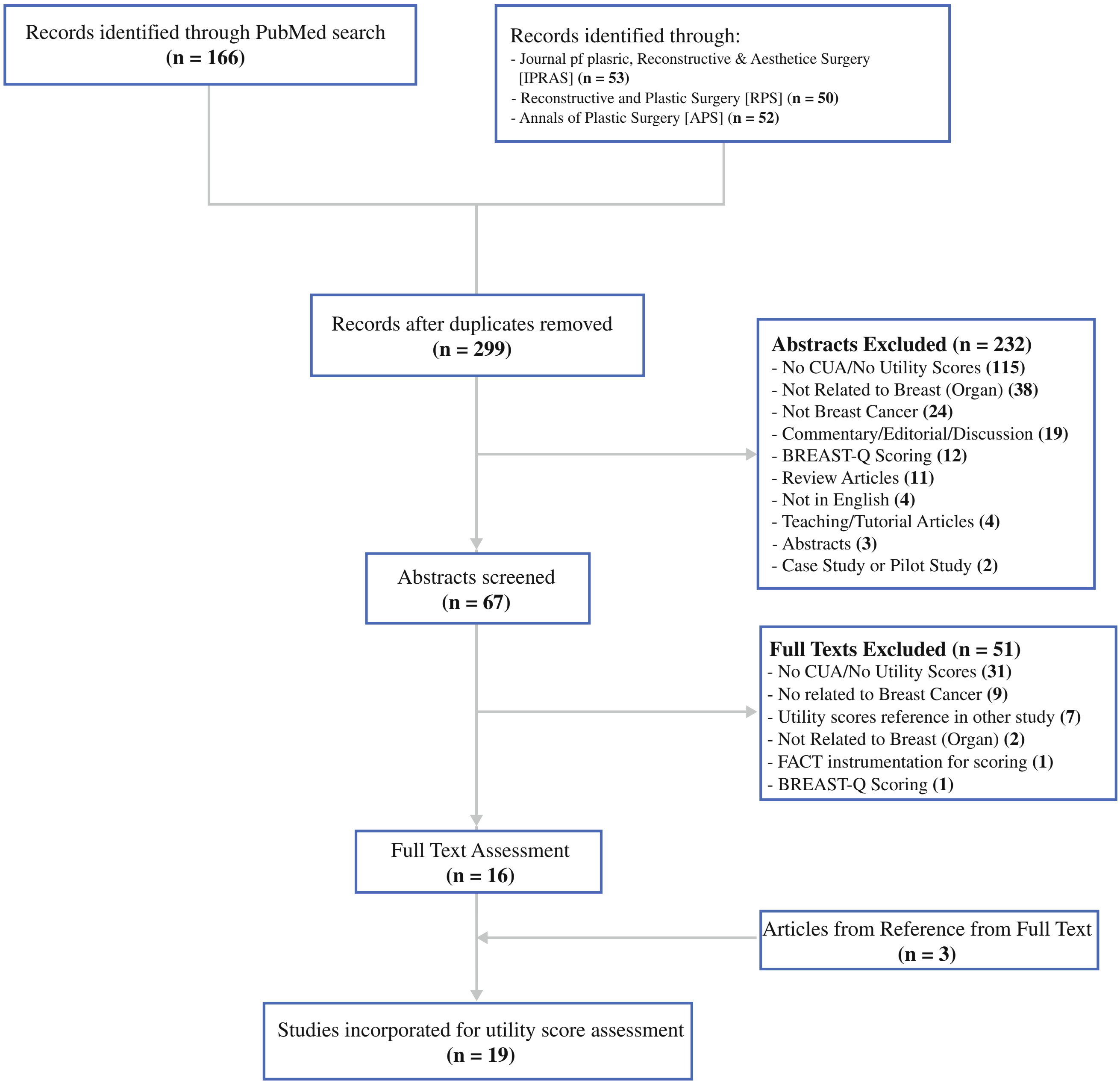

FIG. 1 Selection of articles. This diagram outlines the process in which the articles were selected for the acquisition of utility scores. The articles were initially obtained through MEDLINE and three journals shown above. The abstracts were screened with respect to the exclusion criteria. The remaining articles were assessed via full-text assessment and screened accordingly. References from the remaining articles were explored to assess for studies that align with the preset inclusion criteria

represents the first effort in accumulating utility scores for both the breast oncologic resection and reconstruction.[36–40]

Utility scores are an inherently powerful measure of a health state outcome and serve as a universal scoring tool amongst surgical specialties: 1 indicates perfect health and 0 defines death; the spectrum between measures the success or failure of a surgical approach based on how well such an intervention impacts a patient's final health outcome. Subtle utility score differences amongst competing surgical approaches of less than 0.1 can sway a final value analysis toward one surgical approach over another, heavily influencing decision making in health care.

While utility scores influence the clinical effectiveness for a surgical choice, other variables also play a role when performing CUAs. The actual time spent in a health state is important. If a patient spends the rest of her life in a poor

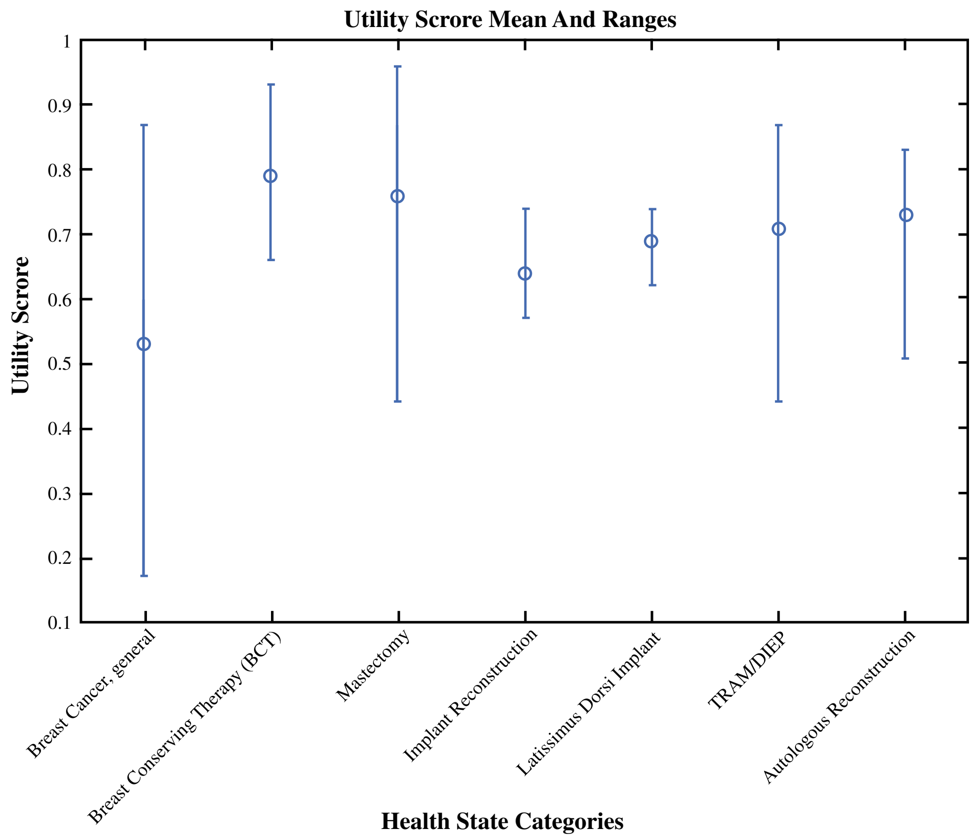

FIG. 2 Ranges for Health State Categories. For the corresponding health state categories presented in Table 2, the mean utility scores are displayed as discrete plots along the *y*-axis. The range of utility scores for each category is portrayed by vertical lines along the *y*-axis. This chart provides visualization of the range of utility scores for each health state category. The breast cancer and mastectomy categories have a wide range of reported utility scores. Latissimus dorsi implant and implant reconstruction categories have relatively narrow ranges. TRAM/DIEP and autologous reconstruction categories have ranges that are relatively moderate compared to the other health state categories (figure generated on MATLAB)

health state, such as having local recurrence leading to a mastectomy and radiation, then that is weighed more heavily in the final clinical assessment than a disease process with a short time spent in a poor health state, such as a mastectomy treated with TRAM flap reconstruction with postoperative infection that is effectively treated with drainage. Additionally, the likelihood of a health state is important. A health state that is rare will have less impact than an equivalent health state that is more common when comparing competing surgical treatment options. Once utility scores are assessed with associated QALYs, costs should then be addressed using ethical practices for CUA.[15,16]

Our results show that there was substantial methodologic variation in the acquisition of utility scores, not only with regard to the assessment tools utilized, but also in the populations surveyed (patients, surgeons, etc.). These results define gaps in the literature with regards to the absence of utility score assessments in nipple sparing mastectomy, and prepectoral implant reconstruction after mastectomy, and oncoplasty. Within oncoplastic surgery, further utility score assessments are needed for both Level I and Level II volume displacement oncoplastic surgeries and volume replacement oncoplastic surgeries.

The literature review and culmination of utility scores summarized in our utility score table provide a bank of values that may be used for QALYs when comparing competing surgical techniques. Such a bank of values provides transparency when choosing utility scores to describe a health state, as the reader can understand what methodologic tools were used to obtain the utility score (VAS, TTO, etc.), what populations were sampled, and the general agreement in the literature. They can choose utility scores obtained from similar methodologic tools and populations to minimize confounding results. Additionally, given the variation present in utility scores for each major breast procedure, this bank of values provides minimum and maximum value utility scores that represent a range for which sensitivity analyses can be performed, further supporting a cost-utility assessment conclusion. CUAs can still deliver meaningful conclusions as long as appropriate ranges are used in the sensitivity analyses performed to justify their conclusions.

While this bank of utility score values is useful, our results show that much more needs to be done to improve the quality of utility score assessment. Much of the scores are observed to be from surgeons or other healthcare professionals. One reason for this may be the ease by which one can obtain such scores from healthcare professionals treating patients and seeing related outcomes. A possible advantage to this may be that scores from surgeons may allow a better reflection for understanding of the surgical risks and perioperative complications across all procedural options as the surgeon has the advantage of seeing the outcomes of all the operation types being done.[33] This may allow some degree of normalization of scores for effective comparisons between operation options. A disadvantage to surgeon reported scores is the reality that they are not directly experiencing the outcome; hence the legitimacy of a patient-reported utility by first-hand experience is difficult to overcome. Yet, there may be reporting bias with patient-reported scores that magnifies their outcome over potential outcomes not experienced. Thus, it is important to declare the population surveyed for utility analyses with appropriate reasons.

The variation of methodologic tools and the differing populations surveyed creates uncertainty in the reliability of the utility scores. In general, breast conservation utility scores are higher than mastectomy utility scores regardless of reconstruction choices. Such a trend also has been supported in the literature using validated patient assessment tools.[41,42] Similarly, successful autologous reconstruction in general has higher utility scores compared to those of implant reconstruction after mastectomy with better aesthetic outcomes and decreased long-term complications when using a patient's autologous tissue.[43,44] Nevertheless, standardization of methodologic tools and populations surveyed is needed. Such decisions should be made by major surgical specialty societies, who then create larger repositories of utility scores open to surgeons for value analyses.

Despite limitations, we were able to compile a large repository of utility scores for breast cancer surgery and reconstruction. Additional research is needed to better assess and incorporate patient interpretation of health states as well as expand assessment to newer surgical techniques. Also, there are other clinical outcome tool measures and scales, such as the BREAST-Q, which have been used in clinical trials. However, to date, there is no conversion factor that translates them into utility scores.[45,46]

CONCLUSIONS

As our health care system evolves and becomes increasingly value conscious, the results of this study demonstrate not only improvements that we can make in gathering health care utilities but also can be used to educate breast care surgeons with the initial tools needed for value analysis in health care. Such understanding is needed for future breast health care advocacy when policy change agendas are brought to the front. Future investigators and policy makers should take into consideration the body of utility scores in assessments of value in healthcare.

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