

# Cost-effectiveness Analysis of Abdominal-based Autogenous Tissue and Tissue-expander Implant following Mastectomy

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**Background:** Patients who had undergone both autologous abdominal tissue (AAT) and tissue expander and implant (TE/I) breast reconstruction reported satisfaction with their reconstruction. While aesthetics and quality of life are important, the cost associated with these procedures must also be considered when choosing one method over the other. The objective of this study was to determine whether AAT-based breast reconstruction is cost-effective compared with 2-stage TE/I reconstruction at a 12-month follow-up.

**Methods:** Thirty-five patients consented and complied to participate in the study with a follow-up of 12 months. The effectiveness of both AAT and TE/I was measured using the Health Utilities Index Mark 3 (HUI-3). From the HUI-3 results, quality-adjusted life years were calculated for each reconstructive approach. Direct healthcare and productivity costs were captured from surgeon billing codes, patient files, and patient diaries. The perspectives of both the Ministry of Health and of society were considered.

**Results:** From the perspectives of both the Ministry of Health and of society, AAT was less effective and more costly when compared with TE/I.

**Conclusions:** In this economic evaluation, TE/I dominated AAT, in that TE/I was more effective and less costly as compared with AAT from the perspectives of both the Ministry of Health and of society at 12 months of follow-up. This conclusion should be interpreted with caution due to a small sample size, the short timespan of the study, and the nonrandomized study design. (*Plast Reconstr Surg Glob Open* 2020;8:e2986; doi: 10.1097/GOX.0000000000002986; Published online 4 November 2020.)

## INTRODUCTION

Providing a comprehensive management of breast cancer requires attention to both oncologic principles and patient health-related quality of life (HRQoL). As such, breast reconstruction should aim to recreate an aesthetically pleasing, natural-looking breast, thereby

improving body image and reducing the negative psychological impact caused by the mastectomy defect. Several techniques exist to accomplish this goal, including breast implants, autologous tissues, or occasionally, a combination thereof.<sup>1,2</sup> Tissue expander and implant reconstruction (TE/I) has become an increasingly common surgical option. Reports suggest that as of 2006, >50% of breast reconstruction procedures are TE/I.<sup>3,4</sup> Increased popularity of TE/I has caused a decrease in autologous procedures from 34.42% in 2005 to 14.57% in 2014.<sup>4</sup>

A systematic review on patient-reported outcomes of TE/I versus autologous abdominal tissue (AAT) breast reconstruction found that, irrespective of the approach, patients found breast reconstruction satisfactory.<sup>5</sup> Although aesthetics and quality of life are important, the cost associated with these procedures must also be considered. Breast reconstruction can be costly to patients (indirect costs), third-party payers, and society, especially as new technologies are introduced in clinical practice. In the past 2 decades, governments and third-party payers have

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been advocating for providing evidence that shows “value for money” by using cost-effectiveness analysis along with clinical studies.<sup>6</sup> The correct methodology to provide such evidence is sound economic evaluations.<sup>7,8</sup> Comparative breast reconstruction economic evaluations have been performed over the years using modeling and decision analytical techniques.<sup>9-11</sup> The main weakness with decision analytic methods is the imprecision and the noticeable heterogeneity around inputs from various sources.<sup>12,13</sup> The crux of this weakness lies in the evaluation of outcomes, which were derived from secondary data in the literature or assumptions prone to bias.<sup>9-11,14</sup> Prospective economic evaluations that use patient-derived data from these studies should provide better evidence.

Unfortunately, most surgeons are not familiar with the methodology of economic evaluations. Most published plastic surgical economic evaluations use the term “cost-effective” incorrectly.<sup>13</sup> Surgeons compare a novel approach with a standard procedure, and if the cost of the novel intervention is less than that of the standard approach, they label it as “cost-effective.” This is only a partial economic evaluation comparing only the cost between treatments. A full economic evaluation, such as cost-effectiveness, cost-utility, or cost-benefit analysis, integrate the costs and effectiveness.<sup>15</sup> In a cost-effectiveness analysis, one derives an incremental cost-effectiveness ratio (ICER), which informs whether novel interventions should be adopted or not. Somewhat arbitrarily, health economists accept the \$50,000/quality adjusted life-years (QALY) as the threshold.<sup>16</sup> Most full economic evaluations in plastic surgery, including our own,<sup>9,10</sup> used a decision analysis modeling based on secondary data. As mentioned earlier, such analyses are prone to bias due to the heterogeneity around inputs from various sources, as mentioned earlier. An arguably better way to perform a cost-effectiveness analysis is to collect data alongside a randomized controlled trial (RCT). Such an approach was used to clarify the role of vertical scar reduction mammaplasty as compared with the inferior pedicle technique.<sup>12,17</sup> However, due to the complexities involved in the management of breast, RCTs cannot always be performed. An alternative design in such case is a prospective study.

The present prospective study was designed to answer the following clinical question: *Is AAT-based breast reconstruction cost-effective compared with 2-stage TE/I reconstruction at a 12-month follow-up?* This time horizon was chosen as the authors believed this length of time would give a good representation of outcomes and complications, while being realistic for patient follow-up.

## METHODS

This was a prospective, pragmatic, single-site study comparing the 2 most common techniques of breast reconstruction in North America: AAT and TE/I. This economic evaluation is based on data collected from a feasibility study.<sup>18</sup> For the purpose of this study, we assumed AAT as the “novel” intervention and TE/I as the “standard” approach. A cost-utility analysis, a variant of cost-effectiveness analysis in which the outcomes are measured in QALYs, was the study design used.

Two expert plastic surgeons experienced in breast reconstruction contributed the reported cases. All cases were performed in Hamilton, Ontario, Canada, and were covered by the Ontario Health Insurance Plan. This study was approved by the Hamilton Integrated Research Ethics Board (HiREB), Project No. 148. This study was registered on clinicaltrials.gov (NCT02438449). This study is reported as per the Consolidated Health Economic Evaluation Reporting Standards checklist.<sup>19</sup>

## Interventions

Patients over the age of 18 years undergoing breast reconstruction (immediate or delayed) after mastectomy procedure on one or both breasts were included in the study. An AAT-based reconstruction was defined as one of the following techniques: pedicled transverse rectus abdominis myocutaneous (TRAM) flap, free TRAM, muscle-sparing TRAM flap, deep inferior epigastric perforator flap, superficial inferior epigastric artery flap, and Rubens flap. The TE/I approach followed a 2-stage reconstruction. In the initial stage, a TE was placed in the subpectoral plane and the defect closed. When appropriate, approximately 2 weeks after surgery, on average, the expansion of the TE commenced until the desired volume of the respective expander was achieved. The second stage included removal of the TE and the placement of a permanent implant. This was a pragmatic study, which means the effectiveness of interventions was evaluated in real-life practice conditions as compared with explanatory trials (which test under optimal conditions). As such, selected implants, hospital admission/discharge, as well as follow-up appointments were made following the standard of care. Pragmatic trials produce results that can be generalized and applied in routine practice settings.

## Perspective

This economic evaluation primarily considered the perspective of the health care payer as recommended by the US Second Panel on Cost-effectiveness in Health and Medicine.<sup>20</sup> In this study, the healthcare payer was the Ministry of Health (MOH) for the province of Ontario, Canada. The perspective of the society was also considered (see Fig. 1).

## Effectiveness

The effectiveness of each approach was measured by patient HRQoL following surgery. The Health Utilities Index Mark 3 (HUI-3) was used to measure HRQOL at baseline

### SOCIETAL COSTS

1. Time lost from work for both patient & caregiver
2. Time lost from activities of daily living for patient & caregiver
3. PLUS all Ministry of Health Costs

### MINISTRY OF HEALTH COSTS

#### Surgery-Related Costs

1. Plastic surgeon-related costs
2. Anaesthesia-related costs
3. Hospital including OR Costs

#### Post-Operative Costs

4. Medications
5. Home-care costs (if applicable)
6. Visits to plastic surgeon/GP/family physician
7. Investigations

**Fig. 1.** Societal and the Ministry of Health costs defined.

and at 1, 6, and 12 months postoperatively. The HUI-3 measures health status in terms of vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain.<sup>21,22</sup> This scale has been used for a wide range of health issues in numerous countries and languages.<sup>23</sup> As one or both breasts may have required reconstruction, the unit of measurement was the patient, and HRQoL was the clinical outcome.

QALYs were calculated using the “Multi-Attribute Utility Function” from the HUI-3 questionnaire. The maximum score that can be obtained for the multi-attribute score is 1, indicating perfect health. The formula used for calculating QALYs was  $QALY = (\text{Baseline Score} + 6\text{-Month Score}) \times 6/12 \times 1/12 + (\text{12-Month Score} + 6\text{-Month Score}) \times 6/12 \times 1/2$ .

**Health Care Use and Costing**

**Direct Medical Costs**

*Hospital-related costs* were obtained from Hamilton Health Sciences Case Costing Specialist Planning & Analysis. Hamilton Health Sciences is a McMaster University-affiliated hospital system where the operations were performed. The average cost per patient represents the total cost of the initial surgery, in-hospital care, the cost of implants/tissue expanders, and the cost of any required revisions/exchanges within 12 months. Microcosting for the operating room expenses is not presently used in our system; instead, operating room costing is provided per procedure type. Costs associated with surgeon assistants are not represented because, in our program, surgical residents act as assistants. The length of hospital stay per patient was obtained from hospital records.

*Surgeon and anesthesiologist fees* were collected using surgeon-submitted Ontario Health Insurance Plan billing codes. The reimbursement for the plastic surgeons and anesthesiologists was derived from the appropriate billing codes for AAT or TE/I in the 2016 Schedule of Benefits for Physicians Services for the province of Ontario, Canada.<sup>24</sup>

**Postoperative Costs**

Postoperative costs included routine follow-up visits with the plastic surgeon and, in the case of TE/I group, the necessary tissue expander inflations. The number of complications and the cost to manage them were obtained from the appropriate billing codes for such complications in the Schedule of Benefits for Physicians Services.

**Productivity Loss**

Productivity loss, the days lost from work, and activities of daily living (ADL) due to the breast surgery, for both the patient and their caregiver, were documented in patient diaries. To assign a monetary value to the time lost from both workdays and ADL, the Human Capital method was used.<sup>15</sup> In this method, the average market wage for *skilled* workers is used to assign a monetary value for *workdays lost*.<sup>15</sup> The average market wage for a skilled worker in Ontario between the ages of 25 and 54 years was used. Archived information from the year 2016–2017 was used, as this was the last year of the study. Accordingly, the loss of 1 day of work would equate to approximately \$229.00.<sup>25</sup> Similarly, to assign a monetary value to lost *ADL*, the hourly wage of *unskilled* labor workers is used.<sup>15</sup> The minimum wage rate in Ontario, Canada, during the 2016–2017 year was \$11.60/hour,<sup>26</sup> or approximately \$92.80 per day.

**Cost–Utility Analysis**

The means and SDs were calculated for the various resources used and other variables related to the 2 breast reconstruction approaches. The calculated costs and effectiveness were tabulated for each procedure. Effectiveness was measured as QALYs; therefore, if one reconstructive approach had a lower mean cost and provided more QALYs, it was deemed the “dominant approach” as it fell in the “win-win” quadrant of the cost-effectiveness plane (Fig. 2). Such approach would then be labeled cost-effective. If both the costs and the effectiveness were higher, an

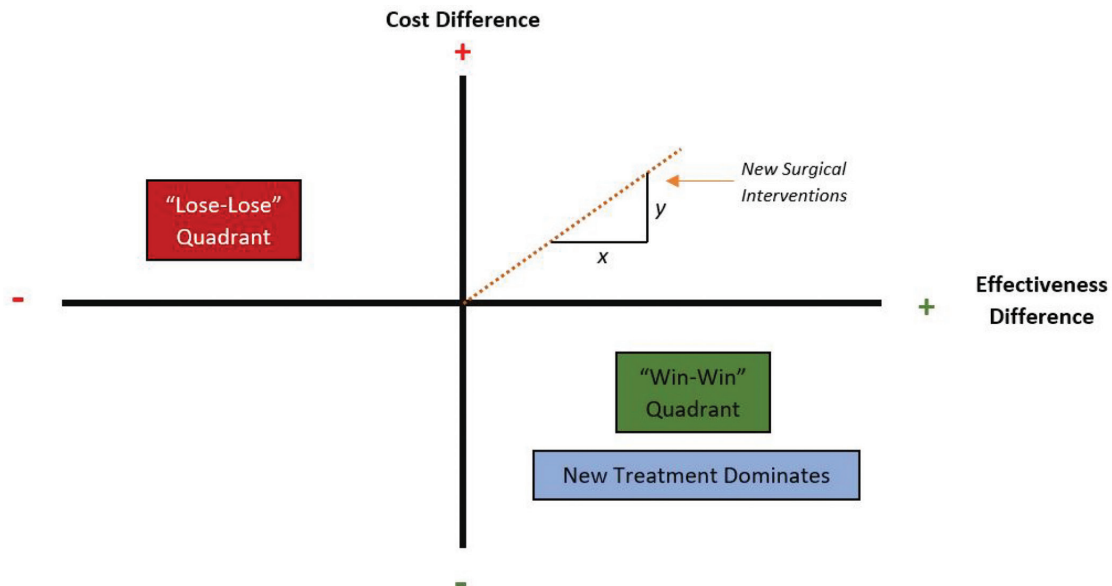


Fig. 2. Illustrative cost-effectiveness plane.

ICER was calculated. This ratio is the difference of costs (y axis) divided by the difference of the effectiveness (x axis) of the 2 reconstructive approaches (Fig. 2). If this ICER fell within the acceptability threshold of \$50,000/QALY, then the procedure would still be considered cost-effective. The use of \$50,000/QALY is a commonly cited threshold within the literature.<sup>16</sup> The ICER represents the additional costs required to gain one additional unit of benefit (ie, cost per QALY gained). To explore and quantify the uncertainty in this economic evaluation, nonparametric bootstrapping to quantify the joint effect of uncertainty around the costs and QALY variables was undertaken.<sup>16</sup> This technique randomly draws with replacement samples of the original cost and QALY data over 1000 replications. These bootstrapped cost-effect pairs are graphically represented on an incremental cost-effectiveness plane. The bootstrapped estimates can be used to construct cost-effectiveness acceptability curves (Fig. 3). These show the probability that AAT is cost-effective compared with TE/I from the perspectives of the MOH and of society.

When analyzing data from the HUI-3, 1 in TE/I and 2 in AAT responses were missing at each time point. Group mean was used to impute the missing values. Together with probabilistic sensitivity analysis, the impact of the missing data and the sampling uncertainty for health utilities was sufficiently dealt with through analyses. Cost-effectiveness analysis data was performed in Microsoft Excel; demographic and HRQoL differences between groups were analyzed in SPSS version 25.<sup>27</sup>

As the time horizon for the study was 12 months, no discounting of costs and QALYs was necessary.<sup>15</sup> The methodology used for the economic evaluation was obtained from Drummond and colleagues<sup>15</sup> and the Methodological guide in performing cost-utility analysis comparing surgical techniques.<sup>28</sup>

## RESULTS

### Patient Recruitment

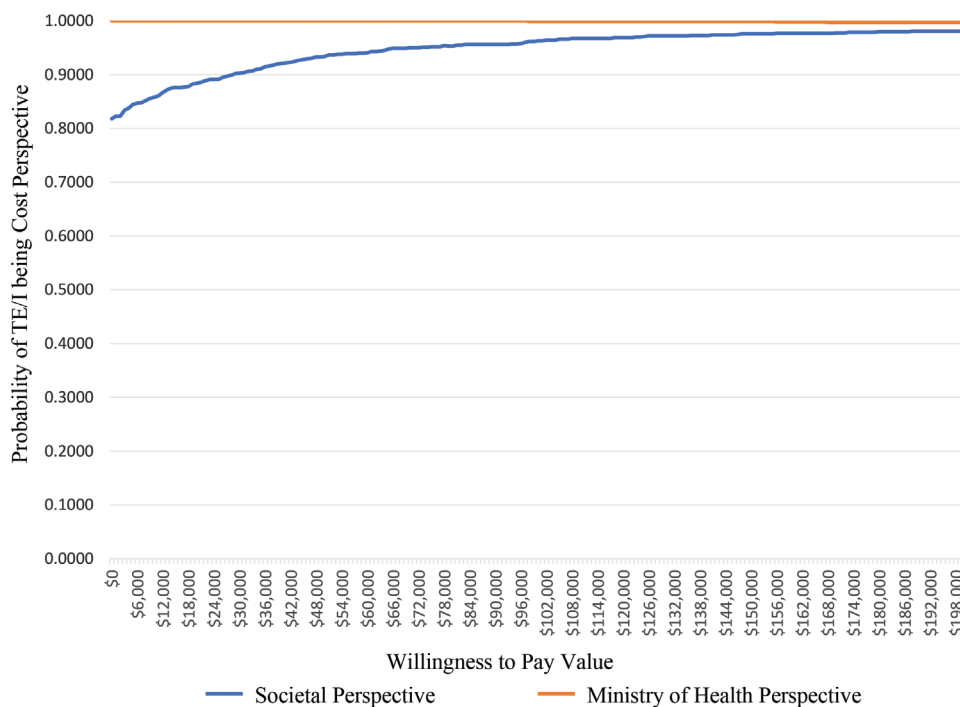
Figure 4 outlines patient recruitment and retention. During recruitment, the decision was made to exclude 3 patients: 2 because of language barriers and the other due to cognitive deficits. As shown in Figure 4, a total of 44 patients consented to participate in the study. By the end of the study, 35 remained: 19 in AAT and 16 in TE/I.

### Patient Characteristics

Table 1 summarizes the patient characteristics of all 44 patients who completed the baseline demographic information. There was a significant difference between body mass index at surgery, with AAT patients having a significantly higher body mass index as compared with the TE/I patients.

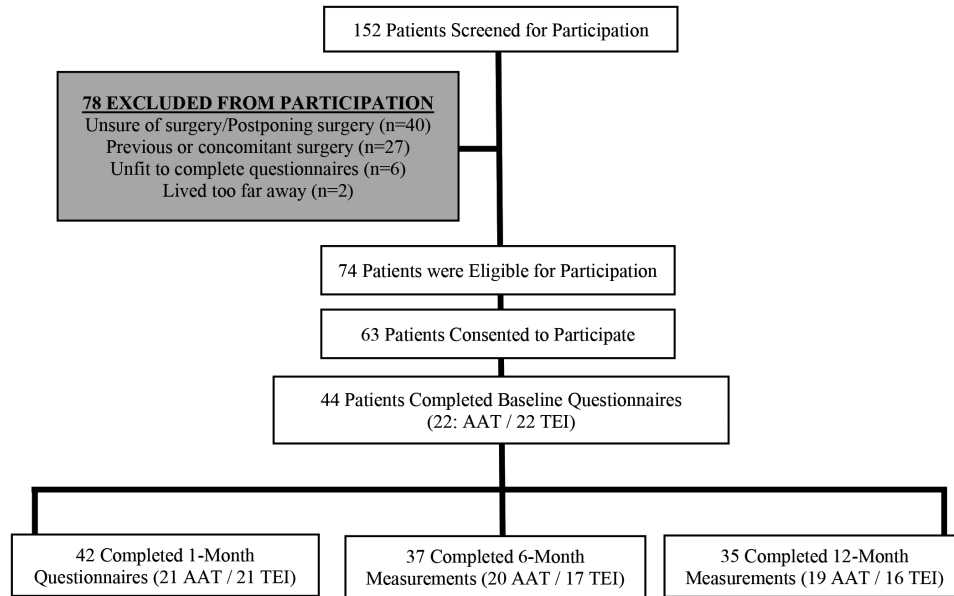
### Health-Related Quality of Life Measure

Table 2 summarizes HUI-3 scores of patient at baseline and at 1, 6, and 12 months postsurgery. At 12 months, no significant differences in scores were detected between



**Fig. 3.** Cost-effectiveness acceptability curves for societal and Ministry of Health (MOH) perspectives. Cost-effectiveness acceptability curves for TE/I breast reconstruction across 2 perspectives. Cost-effectiveness acceptability curves were based on 1000 bootstrap cost-effect pairs. Yellow line represents the MOH perspective; blue line represents the societal perspective. At the willingness-to-pay threshold of \$50,000/QALY, there is >90% probability that the TE/I is cost-effective.





n; number of patients, AAT; Abdominal-Based Autologous Tissue, TE/I; Tissue Expander/Implant

**Fig. 4.** Data on recruitment and retention of participants. n, number of patients.

AAT and TE/I patients. QALYs were calculated at 0.74 for AAT patients and at 0.83 for TE/I patients. A QALY of 1 would indicate that an intervention provided a patient with a full year in perfect health. As such, by receiving the AAT procedure, a patient obtains, what is equal to, 74% of a year, or approximately 9 months, in perfect health. In comparison, the TE/I procedure provides a patient with approximately 10 months of perfect health.

**Costs Related to Surgical Procedures**

Table 3 summarizes surgery details and fees of surgeon and anesthesiologist for AAT and TE/I procedures. When a bilateral procedure is done, the surgeon’s reimbursement consists of 100% payment for 1 breast and 85% for the second. Data are presented for initial and required revisions for both groups.

Table 4 summarizes the costs for each procedure from the perspective of the MOH. Costs for the MOH are categorized by surgery, postoperative medications, and postoperative clinic visits (for follow-ups/inflation of tissue expanders). To calculate the productivity loss (Table 5), data from patient diaries were used. The final

productivity loss amount was a summation of the monetary values associated with lost *workdays* and *lost ADL*. Those patients in the AAT group were burdened with higher productivity losses as compared with those in the TE/I group. The same was seen for the caregivers of these patients.

Through the bootstrapping methods explained above, base-case cost-effectiveness was calculated from from the perspectives of the MOH and of society (Table 6). Values in this table are different from the raw data due to the method of bootstrapping. A cost-effectiveness acceptability curves (Fig. 3) and cost-effectiveness plane (Fig. 5) were created to graphically illustrate these perspectives.

**DISCUSSION**

The guiding principles of the Canadian healthcare system is to provide effective, affordable, and sustainable healthcare for all Canadians. We presume these principles are applicable to most jurisdictions. It behooves all surgeons to consider not only the clinical effectiveness of new innovations but also their cost-effectiveness. The purpose of this

**Table 1. Patient Characteristics**

	AAT		TE/I		Total	
	N	%	n	%	n	%
Unilateral	9	40.9	5	22.7	14	31.8
Bilateral	13	59.1	17	77.3	31	70.5
	22	50.0	22	50.0	44	100.0
	N	$\bar{x}$ (SD)	n	$\bar{x}$ (SD)	n	$\bar{x}$ (SD)
Age at surgery	22	50.3 (7.8)	22	49.7 (10.0)	44	50.0 (8.9)
BMI at surgery*	22	29.1 (6.9)	22	24.4 (4.2)	44	26.6 (6.0)

\*Significant difference  $P < 0.05$ .

n, number of patients;  $\bar{x}$ , mean.

**Table 2. HUI3 Results across Time Points by Surgery Type**

Subdomain	Group	Baseline		1 Month		6 Months		12 Month	
		n	$\bar{x}$ (SD)	n	$\bar{x}$ (SD)	n	$\bar{x}$ (SD)	n	$\bar{x}$ (SD)
Multiattribute score	AAT	22	0.76 (0.27)	20	0.60 (0.25)	18	0.77 (0.15)	16	0.84 (0.13)
	TE/I	21	0.84 (0.15)	21	0.70 (0.24)	18	0.85 (0.13)	16	0.92 (0.08)
Vision	AAT	22	0.96 (0.02)	21	0.95 (0.09)	20	0.94 (0.09)	17	0.96 (0.02)
	TE/I	22	0.97 (0.02)	21	0.97 (0.02)	18	0.96 (0.03)	16	0.97 (0.03)
Hearing	AAT	22	0.99 (0.03)	20	0.99 (0.03)	18	0.99 (0.03)	17	0.99 (0.03)
	TE/I	21	1.0 (0.0)	21	1.0 (0.0)	18	1.0 (0.0)	17	1.0 (0.0)
Speech	AAT	22	1.0 (0.0)	21	0.99 (0.04)	19	1.0 (0.0)	18	0.99 (0.04)
	TE/I	21	1.0 (0.0)	21	1.0 (0.0)	18	1.0 (0.0)	17	1.0 (0.0)
Cognition	AAT	22	0.92 (0.16)	21	0.89 (0.17)	20	0.94 (0.16)	18	0.95 (0.10)
	TE/I	23	0.92 (0.12)	21	0.95 (0.08)	18	0.95 (0.10)	17	1.0 (0.02)
Ambulation	AAT	22	0.96 (0.07)	21	0.83 (0.21)	20	0.97 (0.07)	18	0.97 (0.07)
	TE/I	23	0.99 (0.05)	21	0.97 (0.07)	18	0.98 (0.05)	17	1.0 (0.0)
Dexterity	AAT	22	0.99 (0.04)	21	0.97 (0.12)	20	0.99 (0.04)	18	0.99 (0.03)
	TE/I	23	0.98 (0.06)	21	0.91 (0.23)	18	1.0 (0.0)	17	1.0 (0.0)
Emotional	AAT	22	0.89 (0.19)	21	0.81 (0.23)	20	0.94 (0.08)	18	0.96 (0.07)
	TE/I	23	0.95 (0.09)	21	0.94 (0.1)	18	0.98 (0.04)	17	0.97 (0.07)
Pain	AAT	22	0.87 (0.24)	21	0.76 (0.19)	20	0.88 (0.09)	18	0.92 (0.08)
	TE/I	23	0.93 (0.12)	21	0.72 (0.23)	18	0.89 (0.13)	17	0.95 (0.08)

n, number of patients who completed section of questionnaire;  $\bar{x}$ , mean.

**Table 3. Surgery Details and Reimbursement Fees**

	AAT	TE/I
Initial procedure		
No. patients	19	16
Average length of surgery, min	418	104
Average surgeon reimbursement	\$4412.78	\$929.54
Total surgeon reimbursement	\$83,848.84	\$14,872.61
Average anesthesiologist reimbursement	\$1081.77	\$255.17
Total anesthesiologist reimbursement	\$20,533.68	\$4082.72
Additional required surgical procedures		
No. patients (% of patients)	4 (21%)*	14 (87.5%)†
Average length of surgery, min	—	91
Average surgeon reimbursement	\$704.90	\$724.02
Total surgeon reimbursement submitted	\$2819.59	\$10,136.25
Average anesthesiologist reimbursement	—	\$195.12
Total anesthesiologist reimbursement	—	\$2731.82
Total average cost	\$86,662.44	\$24,754.70

As McMaster University is a teaching hospital, length of surgery may be impacted by training.

\*Four AAT patients required additional surgeries; 3 required secondary procedures, which are often performed upon patient request (eg, nipple areola reconstruction, breast mound revisions), 1 patient required a true revision procedure to address a clotted vein and trim segments of the flap that were not viable.

†Only 14 of the 16 patients received their exchanges within 12 months.

study was to compare the cost-effectiveness of AAT-based breast reconstruction to the 2-stage TE/I reconstruction at 12 months postoperatively. In this trial, AAT was considered as the “novel” intervention. This comparison was done through the perspectives of the MOH and of society.

By visualizing the cost-effectiveness plane quadrants of Figure 2, one can easily decide if a novel intervention (AAT) should be adopted or rejected. If it falls in the right lower quadrant (“win-win” scenario) or the left upper quadrant (“lose-lose” scenario) the decision is straightforward. The problem arises when the novel intervention is more effective but also more costly. It is here that one needs to calculate the ICER. In most jurisdictions in

North America, the acceptable ICER is \$50,000/QALY. The interpretation of this ratio is that we, as a society, are willing to pay \$50,000 to prolong the life of a patient by 1 extra year in perfect health by accepting the “novel” health care intervention and rejecting the “standard” one.<sup>15–17</sup> In the current study, an ICER calculation was not necessary as the AAT breast reconstruction approach was both less effective (less QALYs) and more costly than the TE/I approach. Visually, the AAT fell into the left upper quadrant of the cost-effectiveness plane (ie, loose-loose scenario; Fig. 2). The nonparametric bootstrapped analysis around the 95% confidence interval shows that most of the data fall into the left upper quadrant of the cost-effectiveness plane (Fig. 4). These results indicate that AAT was not cost-effective (ie, it was more costly and less effective) as compared with the TE/I procedure.

Our results contradict those of a study by Matros et al,<sup>29</sup> who found autologous perforator flaps to be more cost-effective as compared with implants. This difference can be explained by the difference in patient populations and methodological rigor between the 2 studies. In terms of methodology, our study used a stochastic analysis in which costs and effectiveness were collected alongside a prospective study. The effectiveness, in QALYs, was measured with a validated utility scale (HUI-3). In the case of Matros et al,<sup>29</sup> they estimated costs from various sources (databases), which can be considered secondary data. They calculated QALYs from the BREAST-Q rather than a validated utility scale, like the EuroQol or the HUI-3, as recommended by health economists.<sup>15</sup> Additionally, they used a decision analytic model in which assumptions were made, especially on the probabilities of the various health states. A prospective study is more likely to provide more accurate data.

There are some weaknesses to our study that should be emphasized. First, the small sample size makes results subject to large uncertainties in the estimation of costs and QALYs. A study with a larger sample of patients could have provided different data. Second, patients were not randomized into either the AAT or the TE/I group. Given the vulnerability of this patient population, patient

**Table 4. Mean Cost per Patient for AAT and TE/I from the Ministry of Health Perspective at 12 Months Postoperatively**

Resource Area	AAT		TE/I		Mean Difference
	n	Mean Cost	n	Mean Cost	
Surgery-related costs					
Plastic surgeon fee	18	\$4561.18	13	\$1547.17	+\$3014.01
Anesthesiologist fee	18	\$1080.72	13	\$454.30	+\$626.42
Allied health	18	\$268.00	13	\$47.00	+\$221.00
Day surgery	18	\$214.00	13	\$390.00	-\$176.00
Laboratory	18	\$1762.00	13	\$1203.00	+\$559.00
Operating room	18*	\$5202.00	13†	\$7009.00	-\$1807.00
Postanesthesia care	18	\$1170.00	13	\$597.00	+\$573.00
Ward costs	18	\$2293.00	2‡	\$966.00	+\$1327.00
Food services	18	\$127.00	2‡	\$55.00	+\$72.00
Subtotal		\$16,677.90		\$12,268.47	+\$4409.43
Postoperative period medications					
Pharmacy	18	260.00	13	70.00	+190
Outpatient clinic visits					
Outpatient clinic visits	88	405.00	123	783.00	-378.00
Grand total		17,342.90		13,121.47	+\$4221.43

Data from the case costing specialist were only available for 18 of the 19 AAT patients and 13 of the TE/I patients.

\*Three of the 18 AAT patients had "secondary procedures," 1 patient had a true revision to address flap issues and a clotted vein.

†Captures 11 TE/I exchanges.

‡Two of the TE/I patients had overnight stays following surgery.

n, number of patients.

**Table 5. Productivity Costs Associated with Work and Personal Days Missed**

	AAT (n = 11)		TE/I (n = 9)		Mean Difference
	Mean Days Missed (SD)	Mean Costs	Mean Days Missed (SD)	Mean Costs	
Time lost from work					
Patient	58.2 (58.5)	\$13,327.80	41.2 (55.2)	\$9439.89	+3887.91
Caregiver	10.7 (8.4)	(\$13,403.75) \$2442.67 (\$1919.60)	5.3 (5.3)	(\$12,653.04) \$1221.33 (\$1189.92)	+1221.34
Subtotal	68.9	\$15,770.47	46.5	\$10,661.22	+5109.25
Time lost from ADL					
Patient	54.6 (37.6)	\$5066.88	39.2 (55.2)	\$3639.82	+1427.06
Caregiver	12.6 (13.2)	(\$3489.08) \$1175.47 (\$1221.48)	3.6 (3.6)	(\$5123.74) \$329.96 (\$331.72)	+845.51
Subtotal	50.8	\$6242.35	42.8 days	\$3969.78	+2272.57
Grand total		\$22,012.82		\$14,631.00	\$7381.82

n, number of patients who reported information.

**Table 6. Summary of Base-case Cost-effectiveness Results across Different Study Perspectives**

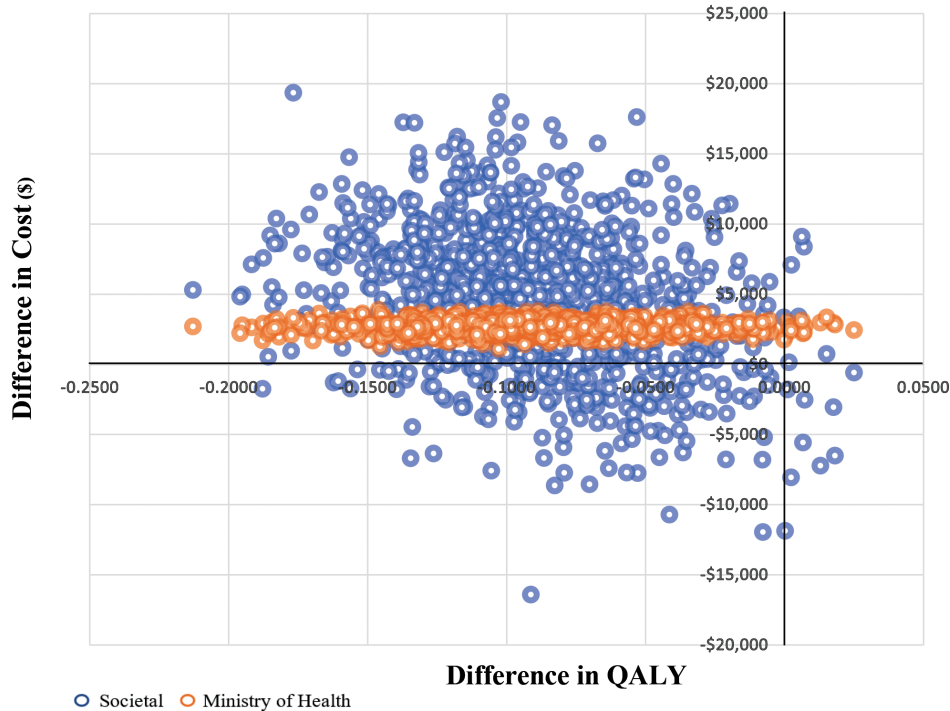
	N	Mean Costs	Mean QALYs	Incremental Costs	Incremental QALYs	ICER
Societal						
AAT	10	\$14,308.00	0.74	\$4574	-0.09	AAT is dominated by TE/I
TE/I	9	\$9734.00	0.83			
MOH						
AAT	18	\$4998.00	0.74	\$2664.00	-0.09	AAT is dominated by TE/I
TE/I	13	\$2335.00	0.83			

n, number of patients.

preference, and the need for neo-adjuvant radiotherapy or chemotherapy, performing an RCT would have been extremely difficult. Nevertheless, surgeons who perform high volume of breast reconstruction are encouraged to attempt an RCT design and couple it with an economic evaluation as described herein. The relatively short time horizon of 12 months is also a limitation; this period does not allow for data collection of potential down-stream complications such as capsular contractures, deflation/degradation of implants, which may require additional surgeries. Additionally, given that data collection began

in 2016, it is possible that inflationary costs for supplies, resources, and staffing could impact outcomes. Finally, the current study did not take several factors (tumor size, chemotherapy, or radiation therapy) into consideration when calculating costs.

In conclusion, this study shows that, within the first year of the postoperative course, AAT is not a cost-effective approach when compared with TE/I. As this analysis was performed with a small sample size and a nonrandomized design, this conclusion should be confirmed with future large sample studies and preferably ones that use an RCT



As most of the dots fall into the left upper quadrant, i.e.: “lose-lose” quadrant of the cost-effectiveness plane this means that the AAT breast reconstructive approach is more costly and less effective.

**Fig. 5.** Cost-effectiveness plane data. Cost-effectiveness probabilistic analysis results, based on 1000 bootstrapped cost-effect pairs: societal perspective is shown in blue; and Ministry of Health (MOH) perspective is shown in orange. Location of each dot is determined by incremental cost and incremental quality-adjusted life year between AAT and TE/T as a result of each simulation. As most of the dots fall in the left upper quadrant, that is, “lose-lose” quadrant of the cost-effectiveness plane, this means that AAT breast reconstructive approach is more costly and less effective.

design. We encourage plastic surgeons who work in centers with high volumes of breast reconstruction patients to carry out additional cost-effectiveness analyses to confirm or refute our conclusions.

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