Published in final edited form as:

Plast Reconstr Surg. 2014 April ; 133(4): 827–840. doi:10.1097/PRS.000000000000019.

Economic Analysis of Revision Amputation and Replantation Treatment of Finger Amputation Injuries

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Abstract

Background—The purpose of this study was to perform a cost-utility analysis to compare revision amputation and replantation treatment of finger amputation injuries across a spectrum of injury scenarios.

Methods—The study was conducted from the societal perspective. Decision tree models were created for the reference case (two finger amputation injury) and seven additional injury scenarios for comparison. Inputs included cost, quality of life, and probability of each health state. A web-based time trade-off survey was created to determine quality adjusted life years (QALYs) for health states; 685 nationally representative adult community members were invited to participate in the survey. Overall cost and QALYs for revision amputation and replantation were calculated for each decision tree. An incremental cost effectiveness ratio (ICER) was calculated if a treatment was more costly but more effective.

Results—We had a 64% response rate (n=437). Replantation treatment had greater costs and QALYs compared to revision amputation in all injury scenarios. Replantation of single digit injuries had the highest ICER (\$136,400/QALY gained). Replantation of three and four digit amputation injuries had relatively low cost-benefit ratios (\$27,100 and \$23,800/QALY respectively). Replantation for distal thumb amputation had a relatively low ICER (\$26,300/QALY) compared to replantation of non-thumb distal amputations (\$60,200/QALY).

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Disclosure:

None of the authors has a financial interest to declare in relation to the content of this article.

This study was presented at the Annual Meeting of the American Association of Plastic Surgeons, April 2013.

Conclusions—The relative cost per QALY gained with replantation treatment varied greatly among the injury scenarios. Situations in which indications for replantation are debated had higher cost per QALY gained. This study highlights variability in value for replantation among different injury scenarios.

Keywords

Economic analysis; cost-utility analysis; replantation; revision amputation; comparative effectiveness

INTRODUCTION

As the technology of microsurgery has advanced over the last 50 years, replantation of finger amputation injuries has become commonplace throughout the world. Finger amputation injuries, whether treated with revision amputation or replantation, have great impact on function, body image, and quality of life. For some injury patterns, such as thumb amputation, multiple finger amputations, and amputations in children, replantation has clearly become established as the standard of care. However, there is continued debate as to whether other injury patterns are best treated with replantation or revision amputation treatment, such as in the case of single digit and distal amputation injuries (1–11).

Consideration of patient preferences, anticipated outcomes, and cost can influence patients, physicians, and policy-makers in preferring one intervention to another. Patient preferences for either treatment based on a desire to minimize complex surgery, potential for prolonged hospitalization, tolerance for risk of complications, delayed return to work, and overall acceptance of anticipated limitations on hand function are also important considerations that are weighted by the patient and treating surgeon. In addition, there is increasing pressure to contain costs and emphasize investment in interventions that demonstrate high value in healthcare (12–17). Therefore, it is important to understand the relative differences in resource use between competing treatments, such as revision amputation and replantation treatments for finger amputation injury. Many studies have evaluated outcomes and complications after replantation alone. Evidence comparing replantation and revision amputation outcomes for various injury scenarios is limited (2, 10, 11, 18). Few studies have discussed the economic impact of replantation and revision amputation (2, 10, 19), and no study has yet applied economic modeling to assess the benefits of replantation and revision amputation by considering both cost and outcomes.

When faced with complex decisions, economic analysis is an important tool to evaluate the impact of preferences, outcomes, and cost to inform decisions for competing treatments. In the case of finger amputation injuries, economic analysis can help to quantify the value of treatments in various injury patterns, particularly in scenarios in which replantation is debated. The purpose of this study was to perform a cost-utility analysis of treatments for finger amputation injuries, and understand the impact of cost, societal preferences, and outcomes when comparing revision amputation and replantation. In addition, we sought to compare the two treatments among a spectrum of clinical scenarios, including level of amputation and number of digits involved.

METHODS

Study Design

The study was approved and granted exempt status by our Institutional Review Board. Decision tree models were created to compare cost and quality of life for revision amputation and replantation treatment for several injury scenarios associated with finger amputations. We followed the recommendations of the Panel on Cost-Effectiveness in Health and Medicine (20, 21). The study was conducted from the societal perspective, meaning that all costs and health effects are estimated for each treatment, irrespective of who experiences them. The societal perspective represents the public interest rather than any single group, such as insurance companies, hospitals, employers, or providers.

The reference case was a two finger amputation injury, which included associated common complications. The two finger injury was chosen because replantation for this injury type is commonly performed and is not controversial, in comparison to a single finger injury. A MEDLINE literature search was performed using keywords “traumatic amputation,” “fingers,” “finger injuries,” and “replantation,” limited to studies of humans and the English language to identify the most common health states associated with replantation and revision amputation for finger amputation injuries. Health states associated with revision amputation included in the study were immediate treatment and initial recovery, typical-long-term consequences without complications, neuroma requiring excision, and chronic pain. Health states associated with replantation included in the study were immediate treatment and initial recovery, typical long-term consequences without complications, vascular complication resulting in salvage or failure, bone or tendon complication, and chronic pain.

Additional cases for comparison were created to compare to the reference case based on varying injury scenarios. Injury scenarios included thumb, one digit, two digit, three digit, and four digit proximal amputation injuries and thumb and two digit distal amputation injuries. These additional cases were simple models that include only immediate treatment and long-term consequences in order to determine relative differences between the injury scenarios. We included a simple model of the two finger amputation injury to compare with the reference case that includes complications to understand the impact of removing complications from the models. In total, there were 21 health states associated with the reference case and additional models (Table 1). Eight decision trees were built to model treatment decisions, representing the reference case (Figure 1) and the seven additional simple models (Figure 2). Complications associated with the reference case were organized into immediate, early, and late time periods to allow individuals to experience more than one complication over the entire course of treatment. The time horizon for the each model was 50 years. Inputs into each decision tree model included cost, quality of life measure, and probability of each health state.

Health State Probabilities

Using the literature search above, we calculated probabilities of health states from studies that reported outcomes of revision amputation and replantation treatment for at least 5 patients per treatment (2, 4, 5, 8, 9, 18, 22–110). Probabilities for each health state were

obtained and were averaged based on sample sizes of each study. Mean probability and range based on minimum and maximums of health states that represent complications are outlined in Table 2.

Quality of Life Measurement and Time Trade-off Survey

Quality adjusted life years (QALYs) are the measure of effectiveness of interventions in cost-utility analyses. Time trade-off questions are a method used to measure preferences for health states, which are further translated into QALYs. Respondents are asked the amount of time they are willing to give up from the end of their life in order to avoid a health state in exchange for shorter life expectancy in perfect health. The more time respondents are willing to give up in order to avoid a health state, the greater negative impact on quality of life, and less preferred a health state is (11). Responses are translated into a utility for the given health state. Utility is a measure of preference, on a scale of 0 to 1, with 0 representing being dead and 1 representing perfect health. Utilities are translated to QALYs by multiplying the utility by the duration of a given health state.

A web-based time trade-off survey was created for this study to determine QALYs for the health states of interest. Scenario descriptions were created to describe the health states included in this study. Injury to the dominant hand was described for all injury scenarios, and an accompanying illustration was included for better comprehension of the digits involved and level of the amputation injury (Text, Supplemental Digital Content 1). Health states for early treatment and recovery and late consequences of each treatment were described for all injury scenarios. However, health states representing common complications (Table 2) were only described associated with the two digit amputation injury scenario to minimize survey burden. In text format, we described the treatment, anticipated impact on physical activity, and most common complications with anticipated duration for each scenario. We performed three rounds of pilot testing on a convenience sample of laypersons and medical professionals to improve understanding of scenario descriptions (n=16).

Each respondent was asked to rate 8 of the 21 health states based on a random assignment to one of 4 survey versions (Table, Supplemental Digital Content 2). We asked respondents to imagine they had a fixed amount of time left to live. After being given a description of the injury scenario and treatment, respondents were asked whether they would trade a fixed amount of time from the end of their life in order to avoid the health state described. The initial amount of time that respondents were asked to consider was randomized among four options to minimize anchoring bias, ranging from 1 week to 2 months for temporary health states and ranging from 6 months to 4 years for permanent health states. As a follow-up question, respondents were asked whether they would be willing to give up more or less time if the response to the initial question was “yes” or “no” respectively. Finally, respondents were asked the maximum time they would be willing to give up from the end of their life to avoid the health state. They were specifically asked to consider the impact of time away from usual leisure or work activities when answering the survey questions. The maximum time respondents were willing to give up was recorded as the trade-off value for each health state and was used for all analyses. The mean time respondents were willing to

trade off was calculated, and responses at the 5th and 95th percentile of were recorded for each health state to derive ranges for sensitivity analysis. Demographic characteristics, including gender, age, race, income, and education, and marital status were collected for each respondent.

Survey Sample

We invited a random sample of 685 adult community members (18 years of age or older) to participate in the time trade-off survey. The sample was selected from a research panel designed to be statistically representative of the U.S. general adult population. The survey was administered via internet by GfK Knowledge Networks (Palo Alto, CA), which recruits panel members by mail from an address-based sample frame representing 97% of U.S. Households (112). This panel has been used to conduct national surveys across various disciplines in medical and social sciences research (113–117). Sampling weights were provided to estimate survey responses representative of the entire panel based on characteristics of responders and nonresponders. We assessed preferences of general community members in order to represent preferences of society. The Panel on Cost Effectiveness in Health and Medicine recommends assessing preferences of a representative community sample when cost-effectiveness analysis data may be used in situations of resource allocation in order to minimize conflict of interest or biases that subgroups may have (20). In addition, when making clinical decisions, preferences for treatments rendered in an emergency setting for finger amputation injuries would be more in line with general community members who do not have prior experience with hand injury. The treating physician typically determines treatment preferences from the patient at the time of injury without the patient having prior experience with hand injury.

Cost

Direct medical cost of initial treatment, hand therapy, and secondary procedures associated with each health state was estimated by Medicare reimbursement rates for 2011. Medicare reimbursement rates represent a standardized federal cost structure that includes professional fees, and facility fees from treatments rendered in the emergency department, inpatient, and ambulatory surgery settings (118–122). Wholesale cost (123) for generic ibuprofen (assumes 400mg taken twice daily) was used to estimate cost of treatment for chronic pain health states. Indirect medical costs were estimated from family members' productivity loss due to time away from work in order to attend to patients during inpatient stays or outpatient appointments. Family member wages were estimated from the average wage index for U.S. workers (124). Estimates of patient productivity loss were not included in cost estimates in order to avoid double counting the impact of lost productivity in both cost and effectiveness estimates (21). The impact of productivity loss was assessed in the trade-off values for each health state by asking respondents to consider time away from leisure activities and work when answering the survey questions. All costs were calculated in 2011 U.S. dollars. Cost components associated with each health state are outlined in Table 3.

Data Analysis

Mean probabilities, costs, and associated QALYs were input for each path in the decision trees. Respondents were asked time they were willing to trade off time from the end of their

life. Thus, these future trade-offs were discounted at a 3% annual rate to reflect time preference and calculate the present value of the trade-off and associated QALYs. All future costs after one year from the injury were also adjusted at a 3% annual rate to calculate the present value costs for each health state. Each decision tree was analyzed with Tree Age Pro decision analysis software (2013 Version; Williamstown, MA), which calculates an overall cost and QALY for each treatment based on the probability of health state combinations associated with each treatment. Cost and QALYs for revision amputation and replantation were calculated for the reference case and each of the seven additional injury scenarios in order to compare cost and outcomes for each treatment for varying injury scenarios. In cases when a treatment was more costly but more effective, an incremental cost effectiveness ratio (ICER) was calculated to determine the additional cost per QALY gained associated with the treatment.

Sensitivity analysis is important in economic analysis to test whether conclusions of the model are robust when assumptions are varied across a range of values. One-way sensitivity analysis varies one input variable at a time, whereas multi-way sensitivity analysis varies more than one input variable at a time. For the reference case, we performed one-way sensitivity analysis across the range of maximum and minimum probabilities for each health state, the 5th and 95th percentile values of health state trade-offs, and across a range of 0.5 – 2.0 times cost estimates for each health state. Input variables that changed the overall results of the model were noted, and the threshold value of the input at which the two treatments had equal outcome was recorded. Multi-way sensitivity analysis was performed with input variables noted to change results in the one-way analysis.

RESULTS

We had a 64% response rate (n=437). Weighted and unweighted sample characteristics were similar (Table 4), thus unweighted responses were used for all data analyses. Responses were excluded if respondents felt they were not confident in answering the survey questions when asked, if more than half of the health states presented were not rated, or if respondents rated all health states with an identical nonzero trade-off value. The final analysis was performed on responses of 403 participants.

Overall cost and QALYs for replantation and revision amputation treatment in the reference case and additional scenarios are shown in Table 5. Cost for replantation treatment was greater than revision amputation in all injury scenarios examined, with a difference of \$14,768 between the two treatments in the reference case, which accounts for costs of complications and secondary procedures. Replantation had greater QALYs for all injury scenarios compared to revision amputation (Table 5). The difference in health effects between the two treatments in the reference case was 0.22 QALYs, or approximately 80 additional days in perfect health with replantation treatment.

ICERs for replantation in the reference case and all injury scenarios are shown in Table 6. We found that inclusion of complications in the two digit amputation injury model more than doubled the ICER for replantation compared to the two digit injury model that did not include complications (\$64,900 versus \$31,000 per QALY gained respectively).

Replantation of single digit injuries had the highest cost-benefit ratio, with \$136,400 per QALY gained. Three and four digit amputation injuries had relatively low cost-benefit ratios for replantation treatment. Lastly, replantation for distal injury involving the thumb had a relatively low ICER (\$26,300 per QALY gained) compared to the ICER for distal replantation of injury not involving the thumb (\$60,200 per QALY gained).

Inputs for cost, probabilities, and trade-offs for each health state in the reference case model were varied one at a time when performing the one-way sensitivity analysis. Variables found to be sensitive by changing the conclusion of replantation being more costly but more effective when tested across the specified range are shown in Table 7. Threshold values for each sensitive variable were much higher than the mean used for respective baseline values except for trade-off values for replantation and revision amputation health states. We performed a two-way sensitivity analysis simultaneously varying trade-offs of the late consequences of each treatment. Figure 3 demonstrates situations when each treatment is preferred across a range of trade off values within the threshold of paying no more than \$100,000 per QALY gained for a more costly but more effective treatment. As the differences in trade-off values between revision amputation and replantation narrows, revision amputation becomes more preferred because it is less costly.

DISCUSSION

This study compared cost and quality of life associated with revision amputation and replantation treatments for multiple finger amputation injury scenarios. Replantation was more costly but more effective in all of the scenarios examined. However, the relative cost spent per QALY gained varied greatly among the injury scenarios. Replantation in the reference case of two digit amputation injury cost \$64,900 per QALY gained compared to revision amputation. Scenarios in which replantation is clearly indicated and most commonly performed had relatively lower cost per QALY gained, such as in thumb replantation and multiple digit replantation. We found that replantation in situations in which indications for replantation are debated had higher cost per QALY gained compared to other injury scenarios. Single digit replantation and distal replantation other than the thumb had the greatest ICERs among the simple models (\$136,400 and \$60,200 per QALY gained respectively). However, respondents rated distal replantation of the thumb with greater preference, resulting in an ICER for distal replantation of the thumb being relatively low (\$26,300 per QALY gained).

Use of an absolute cost-effectiveness threshold to recommend or reject an intervention is debated. Policy-makers are reluctant to consider cost in major healthcare programs due to the fear of being perceived as rationing care. The 2010 Affordable Care Act legislation prohibits inclusion of cost-effectiveness data as a factor in Medicare coverage decisions (125). Commonly cited cost-effectiveness thresholds in the literature range from \$50,000 to \$100,000 per QALY gained (126). Opponents of these thresholds argue that the values are outdated and arbitrary (127). Whereas, others argue that both cost and effectiveness should be considered at least in part to inform fair and transparent decisions in healthcare policy (17, 20, 21, 128–130). Within these commonly discussed thresholds, single digit replantation would clearly not be considered cost-effective. Addition of complications to the

model of single digit injury would fall even further outside this range, suggesting revision amputation as the preferred treatment for these injuries. Distal replantation may also approach the highest accepted threshold of cost-effective treatments if complications were considered in the model, but inclusion of complications into all of the models is beyond the scope of this study. However, in addition to determining an absolute cost per QALY gained, this study provides a better understanding of the relative value of replantation among different injury scenarios based on patient preference and anticipated outcomes. These data should be considered in relation to preferences of individual patients, their tolerance for complications that may prolong recovery, and available resources of the involved health system.

All economic analyses rely on numerous assumptions, and thus have limitations. In using a decision tree model for the analysis, we made the assumption that only one complication occurred at a time. However, we divided complications into immediate, early, and late periods, to allow more than one complication to occur over the treatment course. Decision analysis also attempts to transform complex decisions into more simple models. Patients could potentially experience other less common complications than were included in the model. However, we were required to limit the number of health states that respondents rated to those most likely to impact the overall results. In prioritizing the health states included, we were limited in assessing preferences for complications associated with the two digit amputation injury only. We were unable to assess preferences for complications associated with each additional injury scenario to minimize survey burden. Sensitivity analysis helps to identify variables that are sensitive to change within the assumptions required to develop the model. Changing the trade-off values for short and long-term consequences of revision amputation and replantation treatments had the greatest impact on influencing the overall results. However, respondents consistently rated revision amputation as being associated with lower health-related quality of life than replantation in all injury scenarios. Thus, the conclusions of the model are unlikely to change unless there is a much higher preference toward revision amputation over replantation or a higher probability of complications associated with replantation than was included in the model. Lastly, assessing the impact on productivity loss from the societal perspective, including the patient's perspective and employer's need to replace an injured worker is quite complicated across industries and different work environments. Some injured workers will be quickly replaced without significant impact on the employer and other employers will have a longer period of productivity loss. Alternatively, some patients will receive pay during their recovery period, and others will go unpaid or may be forced to change occupations in the future. For this reason, we assessed the varying impact on lost productivity from the patient's perspective and allowed respondents to consider the impact of the injury on their respective occupation when assessing trade off values for each scenario. We feel this method of accounting for productivity loss allowed inclusion of the short and long-term impact of injury on varying occupations across society, rather than assume that all individuals in the analysis experienced the same impact on their occupation.

Measurement of cost and quality of life associated with competing interventions helps to guide policy and discussions among individual patients and physicians. More recently, advocates of cost-effectiveness analysis argue that data should be used to identify and direct

resources toward interventions having the greatest value in health care. Proponents of value-based care argue that reimbursement and cost sharing should coincide with relative value of interventions, in contrast to the current reality that cost sharing bears little relation to potential benefits of interventions (13, 14, 131). This study highlights variability in value for the same treatment among different injury scenarios. As healthcare providers, we play a role in assuring the efficient use of limited resources in medicine. In this role, it is imperative that we have an understanding of the value of our interventions and clinical situations in which interventions have the greatest relative value.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Support for this study was provided by a grant from the Plastic Surgery Foundation/American Association for Hand Surgery (to Dr. Erika D. Sears), by a grant from the Robert Wood Johnson Foundation/Veterans Affairs (to Dr. Erika D. Sears), and by a Midcareer Investigator Award in Patient-Oriented Research (K24 AR053120) (to Dr. Kevin C. Chung).

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Figure 1.
Reference case decision tree.

Figure 2.
Simple model decision tree.

Sensitivity Analysis on Revision Amputation and Replantation Trade-offs (\$100K Threshold)

Figure 3.

Two-way sensitivity analysis on revision amputation and replantation trade-offs for late complications with \$100,000 per QALY willingness to pay threshold. Dotted lines denote baseline values for trade-offs of each treatment.

Table 1**Health States Associated with Revision Amputation and Replantation Treatments**

Health States*
A. Two finger (IF/MF)– Revision Amputation: No early complication
B. Two finger (IF/MF) – Revision Amputation: No late complication
C. Two finger (IF/MF) – Revision Amputation: Painful neuroma
D. Two finger (IF/MF) – Replantation: No early complication
E. Two finger (IF/MF) – Replantation: Vascular complication
F. Two finger (IF/MF) – Replantation: No late complication
G. Two finger (IF/MF) – Replantation: Bone complication
H. Two finger (IF/MF) – Replantation: Tendon complication
I. Two finger (IF/MF) – Chronic pain
J. Two finger distal amputation (IF/MF) – Revision Amputation: No late complication
K. Two finger distal amputation (IF/MF) – Replantation: No late complication
L. Thumb – Revision Amputation: No late complication
M. Thumb – Replantation: No late complication
N. Thumb distal amputation – Revision Amp: No late complication
O. Thumb distal amputation – Replantation: No late complication
P. Single finger (IF) – Revision Amputation: No late complication
Q. Single finger (IF) – Replantation: No late complication
R. Three finger (IF/MF/RF) – Revision Amp: No late complication
S. Three finger (IF/MF/RF) – Replantation: No late complication
T. Four finger (IF/MF/RF/SF) – Revision Amp: No late complication
U. Four finger (IF/MF/RF/SF) – Replantation: No late complication

* Amputation injury is at base of digit(s) involved unless distal amputation specified

Table 2

Health States and Probabilities

	Health State	Mean	Range	n	# studies	Reference #s
Revision Amputation	Neuroma	0.04	0.00 – 0.05	52	3	(22–24)
	Chronic pain	0.18	0.04 – 0.69	187	6	(2, 23–27)
Replantation	Vascular complication with salvage	0.12	0.00 – 0.42	840	14	(28–41)
	Vascular complication with failure	0.18	0.00 – 0.36	8,004	85	(4, 5, 8, 9, 18, 28–107)
	Bone complication (nonunion/malunion)	0.09	0.06 – 0.67	806	7	(5, 9, 41, 61, 74, 103, 108)
	Tendon complication (severe stiffness)	0.23	0.08 – 0.78	413	10	(9, 32, 38, 41, 57, 67, 74, 108–110)
	Chronic pain	0.06	0.00 – 0.65	548	5	(2, 48, 61, 70, 110)

Table 3

Cost Components Associated with Each Health State

	Health State	CPT Code	Operative Time	# OT/MD Visits	Surgeon	Anesthesia	Facility	Therapy	Indirect	Medications	Total Cost*
Reference Case	2 digit revision amputation treatment	26951, 26951	-	24	\$1,011	-	\$813	\$1,043	\$1,900	-	\$4,766
	Neuroma excision	64776	1 hour	8	\$421	\$162	\$604	\$370	\$684	-	\$2,241
	Chronic pain	-	-	-	-	-	-	-	-	\$541	\$541
	2 digit replantation treatment	20816, 20816	5 hours	32	\$3,470	\$603	\$8,361	\$1,379	\$2,508	-	\$16,321
	Vascular re-exploration with salvage	35231	4 hours	-	\$1,391	\$510	-	-	\$456	-	\$2,357
	Vascular re-exploration with failure	35231, 26951**	4 hours, 1 hour	-	\$2,064	\$672	-	-	\$456	-	\$3,193
	Bone complication (nonunion/malunion)	26546	2 hours	32	\$1,041	\$255	\$940	\$1,379	\$2,508	-	\$6,123
	Tendon complication (staged tendon reconstruction)	26390, 26500, 26392**	2 hours, 2 hours	48	\$2,256	\$510	\$2,150	\$2,052	\$3,800	-	\$10,768
	Chronic pain	-	-	-	-	-	-	-	-	\$541	\$541
	Thumb revision amputation	26951	-	24	\$674	-	\$542	\$1,043	\$1,900	-	\$4,159
Additional Scenarios	Thumb replantation	20827	4 hours	32	\$2,173	\$510	\$8,361	\$1,379	\$2,508	-	\$14,931
	Thumb revision amputation - distal	26951	-	24	\$674	-	\$542	\$1,043	\$1,900	-	\$4,159
	Thumb replantation - distal	20827	4 hours	32	\$2,173	\$510	\$8,361	\$1,379	\$2,508	-	\$14,931
	1 digit revision amputation	26951	-	24	\$674	-	\$542	\$1,043	\$1,900	-	\$4,159
	1 digit replantation	20816	4 hours	32	\$2,314	\$510	\$8,361	\$1,379	\$2,508	-	\$15,072
	2 digit revision amputation	26951, 26951	-	24	\$1,011	-	\$813	\$1,043	\$1,900	-	\$4,766
	2 digit replantation	20816, 20816	5 hours	32	\$3,470	\$603	\$8,361	\$1,379	\$2,508	-	\$16,321
	2 digit revision amputation - distal	26951, 26951	-	24	\$1,011	-	\$813	\$1,043	\$1,900	-	\$4,766
	2 digit replantation - distal	20822, 20822	4 hours	32	\$3,141	\$510	\$8,361	\$1,379	\$2,508	-	\$15,899
	3 digit revision amputation	26951, 26951, 26951	-	32	\$1,348	-	\$1,083	\$1,379	\$2,508	-	\$6,318
	3 digit replantation	20816, 20816, 20816	6 hours	32	\$4,627	\$696	\$8,361	\$1,379	\$2,508	-	\$17,571
	4 digit revision amputation	26951, 26951, 26951, 26951	-	32	\$1,684	-	\$1,355	\$1,379	\$2,508	-	\$6,926

	Health State	CPT Code	Operative Time	# OT/MD Visits	Surgeon	Anesthesia	Facility	Therapy	Indirect	Medications	Total Cost *
	4 digit replantation	20816, 20816, 20816, 20816	7 hours	32	\$5,784	\$788	\$8,361	\$1,379	\$2,508	-	\$18,820

* costs incurred after 1 year discounted at 3% annual rate

** procedure performed on separate date, thus multiple procedure discount not applied

Table 4

Weighted and Unweighted Sample Characteristics

Sample Characteristics (n=403)	Unweighted	Weighted
Gender		
Female	53.1%	52.1%
Male	46.9%	47.9%
Age		
18 – 29	20.4%	21.5%
30 – 44	21.3%	26.0%
45 – 59	29.8%	28.0%
60+	28.5%	24.5%
Race/Ethnicity		
White, non-hispanic	71.7%	66.5%
Black, non-hispanic	8.4%	11.6%
Other, non-hispanic	4.0%	5.2%
Hispanic	13.9%	14.8%
2+ races, nonhispanic	2.0%	1.9%
Education		
Less than high school	11.7%	13.3%
High school	31.8%	29.7%
Some college	28.8%	29.4%
Bachelor's degree or higher	27.8%	27.6%
Income		
<=29,999	23.6%	24.0%
30,000 – 59,999	25.3%	26.1%
60,000 – 99,999	24.3%	25.6%
>=100,000	26.8%	24.4%
Marital Status		
Married	57.8%	53.7%
Widowed, divorced, separated, never married	42.2%	46.3%

Table 5

Cost and QALYs for Reference Case and Additional Models

	Injury Scenarios	Costs*		QALYs*	
		Amputation n	Replantation n	Amputation n	Replantation n
Reference Case** Complications)	2 Digit (IF/MF)	\$4,953	\$19,721	24.04	24.26
Additional Cases** (Without Complications)	Thumb	\$4,159	\$14,931	24.94	25.21
	Thumb - Distal	\$4,159	\$14,931	24.97	25.38
	1 Digit (IF)	\$4,159	\$15,072	25.44	25.52
	2 Digit (IF/MF)	\$4,766	\$16,321	24.81	25.18
	2 Digit (IF/MF)-Distal	\$4,766	\$15,899	24.90	25.09
	3 Digit (IF/MF/RF)	\$6,318	\$17,571	24.70	25.12
	4 Digit (IF/MF/RF/SF)	\$6,926	\$18,820	24.49	24.99

* Future cost and QALYs both discounted at annual rate of 3% to determine present value, assuming 50 years life expectancy

** Cases are proximal injuries (at base of digit) unless otherwise indicated

Table 6

Incremental Cost Effectiveness Ratios for Reference Case and Additional Scenarios

	Injury Scenarios	ICER*
Reference Case** (With Complications)	2 Digit (IF/MF)	\$64,900
Additional Cases** (Without Complications)	Thumb	\$40,500
	Thumb - Distal	\$26,300
	1 Digit (IF)	\$136,400
	2 Digit (IF/MF)	\$31,000
	2 Digit (IF/MF) - Distal	\$60,200
	3 Digit (IF/MF/RF)	\$27,100
	4 Digit (IF/MF/RF/SF)	\$23,800

* ICER measured in dollars per quality adjusted life year gained

** Cases are proximal injuries (at base of digit) unless otherwise indicated

Table 7

Sensitive Variables and Threshold Values for Reference Case One-Way Sensitivity Analysis

Variable	Baseline Value	Range	Threshold Value
Probability replantation tendon complication	0.23	0.08 – 0.78	0.75
Probability replantation bone complication	0.09	0.06 – 0.67	0.61
Trade-off amputation no early complication (years)	0.8	0 – 5	0.52
Trade-off amputation no late complication (years)	0.95	0 – 10	0.61
Trade-off replantation no early complication (years)	0.51	0 – 5	0.79
Trade-off replantation no late complication (years)	0.58	0 – 5	0.87
Trade-off replantation immediate complication (years)	0.52	0 – 5	1.28
Trade-off replantation tendon complication (years)	0.53	0 – 5	1.74
Trade-off replantation bone complication (years)	0.53	0 – 5	3.62