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Evaluating Health Economic Outcomes of Autologous Skin Cell Suspension for Definitive Closure in US Burn Care Using Contemporary Real-World Burn Center Data

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Abstract

Background: As new treatments for managing patients with burn injuries become available, it is imperative to consider the overall potential impact of both patient outcomes and costs to the burn center (BC). Health economic evaluations (HEE) can aid BC to assess new treatment options. Historically, the National Burn Repository (NBR) has aided in HEE with two limitations-variables are captured in an aggregate fashion over a 10-year period and it has limited data on resource utilization and procedure types. This prohibits real-world evidence development and effective HEE for new treatments. Our goal was to collect timely real-world data (RWD) and conduct a HEE to better understand the differences between anecdotal evidence and RWD in burn care treatment patterns and outcomes.

Objective: To re-evaluate the economic impact of Autologous Skin Cell Suspension (ASCS) by conducting a primary research survey using RWD from BC on the current state of treatment care in order to identify trends since 2011 that impact evaluation of new interventions.

Methods: 10% of U.S. burn centers were surveyed in 2019 by a panel of health economists on current BC practice patterns and outcomes. Survey data functioned as RWD with NBR 8.0 data in a previously developed health economic model (BEACON). A HEE was conducted with ASCS compared to standard of care (SOC) in a cost-effectiveness model for inpatients with deep-partial thickness (DPT) and full-thickness (FT) burn injury involving ≥10%TBSA. The costs-effectiveness model incorporated costs of patient care from RWD and data from the NBR predictive equations method.

Results: ASCS was cost-saving in both FT and DPT burns across all TBSA ranges. Cost savings increased with burn size due to the reduced number of autograft procedures, LOS and costs compared to SOC. Savings ranged from 1% to 43% in 10% and 40 % TBSA, respectively in FT, and 25% to 41% in 10% and 40% TBSA, respectively among DPT burns. For a hypothetical BC with an average of 341 patients, the use of ASCS is expected to reduce overall costs by an estimated $15.8M for the center and $79.5K (17.4% reduction) per patient, on average.

Conclusion: The study provides the first HEE from RWD confirming the BEACON model and the potential of new technologies in burn care. We observed that use of ASCS has the potential to provide substantial financial savings to BC, corroborating findings of the original HEE of ASCS with the BEACON model.

Keywords

Burn care, health economics, real-world data, treatment patterns, total body surface area, burn depth

Introduction

Every year, there are around 180,000 deaths worldwide due to burns, with non-fatal burn injuries being a leading cause of morbidity such as prolonged hospitalization, and disfigurement and disability[1]. According to Centers for Disease Control and Prevention (CDC), 1.1 million burn injuries require medical attention in the United States (U.S.) every year (2002 data) of which, around 50,000 require hospitalization [2]. According to National Burn Repository (NBR) 2019 report, 76.3% of total burn cases that required hospitalization were less than 10% TBSA and among burns with TBSA>10%, 57.7% fall within 10-19.9% TBSA[3]. Every year, there are approximately 3,400 burn-related deaths in the U.S. [4]. Although burns vary in terms of affected tissue, severity, and resulting complications, the associated medical cost burden in the U.S. is significant with an estimated economic burden of over $8.4 billion per year (2020, inflated from 2018) for hospitalizations, emergency department visits, and deaths [5].

Severe burns with over 40% TBSA in adults are at high risk for morbidity and mortality, even when treated in highly specialized burn centers[6] According to the American College of Surgeons, several advancements have taken place in burn management with the integration of new technologies and treatment paradigms into routine care. There is a three to five-fold decrease in mortality today compared to the 1980's with the percent of TBSA burned, age, and the presence of inhalation injury being the most important predictors. Burn patients up to age 40 with a 95% TBSA burn now survive 50% of the time, whereas in earlier times a 50% TBSA burn in the same patient resulted in death [7]. Major factors responsible for this change include advances in the standard of care, including protocols for management of inhalation injury; nutrition to combat infection and aid in healing; and receiving early burn excision and skin grafts immediately following injury[7]. Even with new interventions and treatment protocols, effectively managing burns remains a challenge given the significant morbidity and mortality among burn patients.[8] Although, new interventions are being developed, there remain limited alternatives for effectively managing patients, minimizing morbidity, and mitigating the substantial cost of burn injury for severe burns requiring surgical intervention 8[8].An Autologous Cell Harvesting Device (ACHD) which produces an Autologous Skin Cell Suspension (ASCS) is an innovative technology approved by FDA in 2018 for the treatment of acute thermal burn wounds. Evidence demonstrates that ASCS achieves comparable definitive closure outcomes to conventional autografts while significantly reducing donor site requirements [9,10,11]. Novel interventions such as ASCS may improve patient outcomes by reducing infection rates, decreasing time to wound closure, reducing length of stay (LOS), reducing number of surgeries and/or need for post-burn rehabilitation [5]. Hence, it is important to consider the likely impact of interventions on costs and healthcare resource use within the burn care continuum more broadly to help inform coverage decisions and treatment guidelines as clinical impact of novel interventions may be translated into positive economic consequences for the burn center. A burn center perspective cost-effectiveness model (CEM) of the burn care pathway, known as the Burn-MCM (medical counter measure) Effectiveness Assessment Cost Outcomes Nexus (BEACON) model was previously developed to evaluate the cost-effectiveness and burn center budget impact from the use of various interventions in the burn care treatment pathway for severe burns. In this study, BEACON was used to evaluate the economic impact of ASCS compared to conventional STSG for the management of inpatient burns. Detailed background on ASCS, BEACON model, structure, patient profile, clinical inputs, costs and resource use, results of budget-impact and cost-effectiveness analyses have been published elsewhere [5].

Data for the previously published BEACON model were primarily obtained from National Burn Repository (NBR) version 8.0 encompassing 2002-2011 data and a cost survey conducted in 2017 which was primarily used to capture cost data not available in the NBR [12]. The NBR is a database of patients treated at burn centers which includes detailed patient and clinical characteristics, description of injuries, mechanisms causing them, course of burn treatment and disposition after discharge. Every year, approximately 90 U.S. burn centers, several Canadian and a few international centers contribute data to the NBR, and the ABA publishes an annual summary report of the NBR consisting of the most recent 10 years [13]. Although, the NBR captures a range of concepts, the public summary reports most readily available to burn centers focus on aggregate data, and comparison of trends based on patient characteristics such as age, TBSA and burn depth are not possible because nuanced results are not reported across key variables such as LOS, procedure trends and resource use. Hence, the use of current real-world data to evaluate the impact of new burn care technologies and interventions in economic models is essential.

Real world data has been defined by the Federal Drug Administration (FDA) as data relating to patient health status or the delivery of health care. It can be collected from electronic health records, claims or billing activity, disease or injury registries, and even patient-generated data from personal devices. The FDA has also announced that it uses real-world data to monitor safety and adverse events post market approval and to aid in the development of regulator decisions. Third-party payers use the data to develop guidelines and decision support tools for coverage decisions which directly impacts patients and health professions. These changes with the information age have increased the value of real-world data and led to the development of real-world evidence.

The objective of the current study is to re-evaluate the economic impact of ASCS by integrating real-world data from burn centers on the current state (2019) of burn care obtained through a primary data collection into validating the findings of the original economic evaluation of ASCS given the advances in burn care.

Materials and Methods

Real World Burn Care Trends Survey

A survey was developed and administered to 14 burn surgeons, representing a 10% sample of U.S. burn centers (n=136) nationally between June and December 2019 by a panel of experienced health economists. Details on the methodology and outcomes of the survey are published elsewhere. The survey provided information on existing assumptions and data inputs (based on BEACON inputs) and prompted the burn centers to update this information based on their own burn center practices. The survey collected information across several domains, including: burn center characteristics; burn patient characteristics including number of patients, TBSA and depth of burn; aggregate number of types of procedures; and resource use such as operating room/surgery time, length of stay (LOS), and dressing changes. Additionally, specific costs, resource use and procedure trends were also captured in burns with TBSA ≤20% to understand differences in care pathways for less severe burns.

Data for all centers were combined, summaries were developed and compared using descriptive statistics, based upon averages for all quantitative responses. Comparisons of key survey outcomes such as number of procedures and costs were made across burn center characteristics (i.e., region, size) to understand variations in treatment patterns and outcomes from the national averages over time. Benchmark estimates were then integrated into the BEACON model to re-evaluate the impact of ASCS considering the latest SOC data from burn centers.

BEACON model

Structure

The CEM within BEACON evaluated a single inpatient stay for the management of a severe burn from a burn center perspective. The model received patient characteristics as input and then utilized linked, sequential decision trees across multiple treatment pathway modules including wound assessment, debridement/excision, temporary coverage, definitive closure and rehabilitation, to estimate the clinical and economic outcomes associated with each phase of care, and overall, during inpatient care. The budget impact model (BIM) was built on the CEM to capture the impact of interventions on costs and patient outcomes for a burn center overall, accounting for key drivers specific to the burn center, such as the expected patient mix by burn depth, TBSA burned, and other individual patient characteristics. The model compared costs for the two treatment pathways (with and without the use of ASCS) to isolate the likely shift in costs related to ASCS use. The model also allows users to select conservative approximation vs. NBR predictive equations methods to calculate number of procedures for SOC only [5,14]. The conservative approximation method assumes a single conventional autografting procedure with STSG for patients with TBSA ≤ 20% and two conventional autografting procedures with STSG for patients with TBSA > 20% whereas the NBR predictive equations estimate the number of procedures to obtain definitive closure via conventional autografting with STSG (by burn depth and TBSA) by using ICD-9 procedure codes to identify conventional procedures for SOC within the NBR data. An overview of the burn care pathway and core assumptions involved in the models are detailed in the publication by Kowal S et al[5] with the original evaluation of ASCS with BEACON.

Patient profile

The target population for the model includes adults (average age of 42 years) having severe burns with TBSA ≥ 10% who receive inpatient care, where DPT and FT/mixed-depth burns are eligible for ASCS.

Clinical Inputs

Clinical inputs previously used in the BEACON model were supplemented with latest survey data, specifically for phases impacted by ASCS such as definitive closure. Key clinical inputs obtained from the survey are reported in *Table 1*.

Table 1. Key clinical inputs obtained from the survey

Variable	Patient profile	Input
Blood requirements per % TBSA (ml) for excision (FT/mixed-depth)	TBSA 10%	30.6
	TBSA 20%	42.6
Blood requirements per % TBSA (ml) for excision (DPT)	TBSA 10%	30.6
	TBSA 20%	53.9
Frequency of coverage changes (daily) (FT/mixed-depth, DPT)	All TBSA	0.98
Number of autograft procedures (STSG, FT/mixed-depth)	TBSA 10%	1.2
	TBSA 20%	2.2
	TBSA 30%	2.6
	TBSA 40%	3.8
Number of autograft procedures (STSG, DPT)	TBSA 10%	1.1
	TBSA 20%	1.8
	TBSA 30%	2.4
	TBSA 40%	3.0
Total surgical time for the graft site (mins/ surgical TBSA%) (FT/mixed-depth)	TBSA 10%	5.9
	TBSA 20%	5.1
	TBSA 30%	4.7
	TBSA 40%	4.4
Total surgical time for the donor site (mins/surgical TBSA %) (FT/mixed-depth)	TBSA 10%	3.0
	TBSA 20%	2.6
	TBSA 30%	2.4
	TBSA 40%	2.3

Total surgical time for the graft site (mins/surgical TBSA% (DPT)	TBSA 10%	5.5
	TBSA 20%	4.7
	TBSA 30%	4.4
	TBSA 40%	4.1
Total surgical time for the donor site (mins/surgical TBSA%) (DPT)	TBSA 10%	2.9
	TBSA 20%	2.6
	TBSA 30%	2.3
	TBSA 40%	2.2
Time for each dressing change (min/ surgical TBSA%) (FT/mixed-depth, DPT)	TBSA 10%	2.6
	TBSA 20%	2.4
	TBSA 30%	2.4
	TBSA 40%	2.2
LOS for contracture surgery (FT/mixed-depth)	TBSA 10%	1.8
	TBSA 20%	2.0
	TBSA 30%	2.2
	TBSA 40%	2.3
LOS for contracture surgery (DPT)	TBSA 10%	1.7
	TBSA 20%	1.8
	TBSA 30%	2.0
	TBSA 40%	2.1

Cost Inputs

Key cost elements obtained from the survey include bed cost per day, anesthesiology cost per patient and cost of burn surgery operating room (OR) time per hour. Other cost inputs for the model which were obtained in 2017 remained same as in the original evaluation of ASCS. All unit costs were adjusted to 2020 USD and are reflective of average costs reported by burn centers. These costs are reported in *Table 2*.

Table 2. Key cost inputs obtained from the survey

Provider resource use element	Unit	Cost (US 2020)
Cost per day for burn patients	per day	$8,607.37
Cost per day for burn patients (TBSA: 10%, 20%)	per day	$7,775.65
Burn surgery operating room time	per hour	$4,985.89
Anesthesiology	per patient	$5,338.89
Anesthesiology (FT/mixed-depth: TBSA 10%, 20%)	per patient	$4,843.82
Anesthesiology (DPT: TBSA 10%, 20%)	per patient	$4,841.04

Analyses

Cost-effectiveness analysis

The BEACON model is customizable and can be used with individual burn center data. However, the results presented are based on averages obtained from sample burn centers that participated in the survey and are reported for adult patients (average age of 42 years) with TBSA 10%, 20%, 30%, and 40% for DPT and FT/mixed-depth burns, which were controlled for comorbidities obtained from NBR data. The analysis was conducted using the NBR predictive equations method. Overall patient characteristics remained the same for DPT and FT/mixed-depth burns, however the model inputs were varied as reported in Tables 1 and 2 to account for the impact of wound depth on LOS and amount of donor skin harvested (and associated impact on surgery time) (*Table 3*. One-way sensitivity analysis (OWSA) was also conducted for each patient profile.

Table 3. Cost-effectiveness and budget impact patient profiles

Details of patient profiles for the cost-effectiveness model[a]				
TBSA	**10%**	**20%**	**30%**	**40%**
Patient characteristics				
Female (%)	26%	23%	27%	27%
Age (years)	42	42	42	42
BSA (cm^2)	19,808	19,856	19,788	19,783
Size of burn (cm^2)	1,981	3,971	5,936	7,913
Comorbidities				
Inhalation injury (%)	4%	9%	13%	25%
Hospital-acquired infection (HAI) (%)	1%	3%	4%	9%
Other infection (%)	2%	5%	4%	5%
Diabetes (%)	6%	6%	3%	4%

Details of default settings for a burn center with 341 patients annually			
	FT or mixed depth No. Patients (%)	**DPT** No. Patients (%)	**SPT[b]** No. Patients (%)
Wound depth distribution	103 (30.2%)	96 (28.3%)	141 (41.5%)
Proportion of burns			
TBSA>40% (average 48%)	15 (15%)	9 (9%)	7 (5%)
TBSA 21-40% (average 28%)	33 (32%)	25 (26%)	32 (23%)
TBSA 10-20% (average 15%)	55 (53%)	62 (62%)	102 (72%)

[a] Source: Inputs for CEM based on analysis of NBR data from BEACON model
[b] Superficial partial thickness patients receive no STSG or ASCS as they are assumed to heal within 21 days.

Budget impact analysis

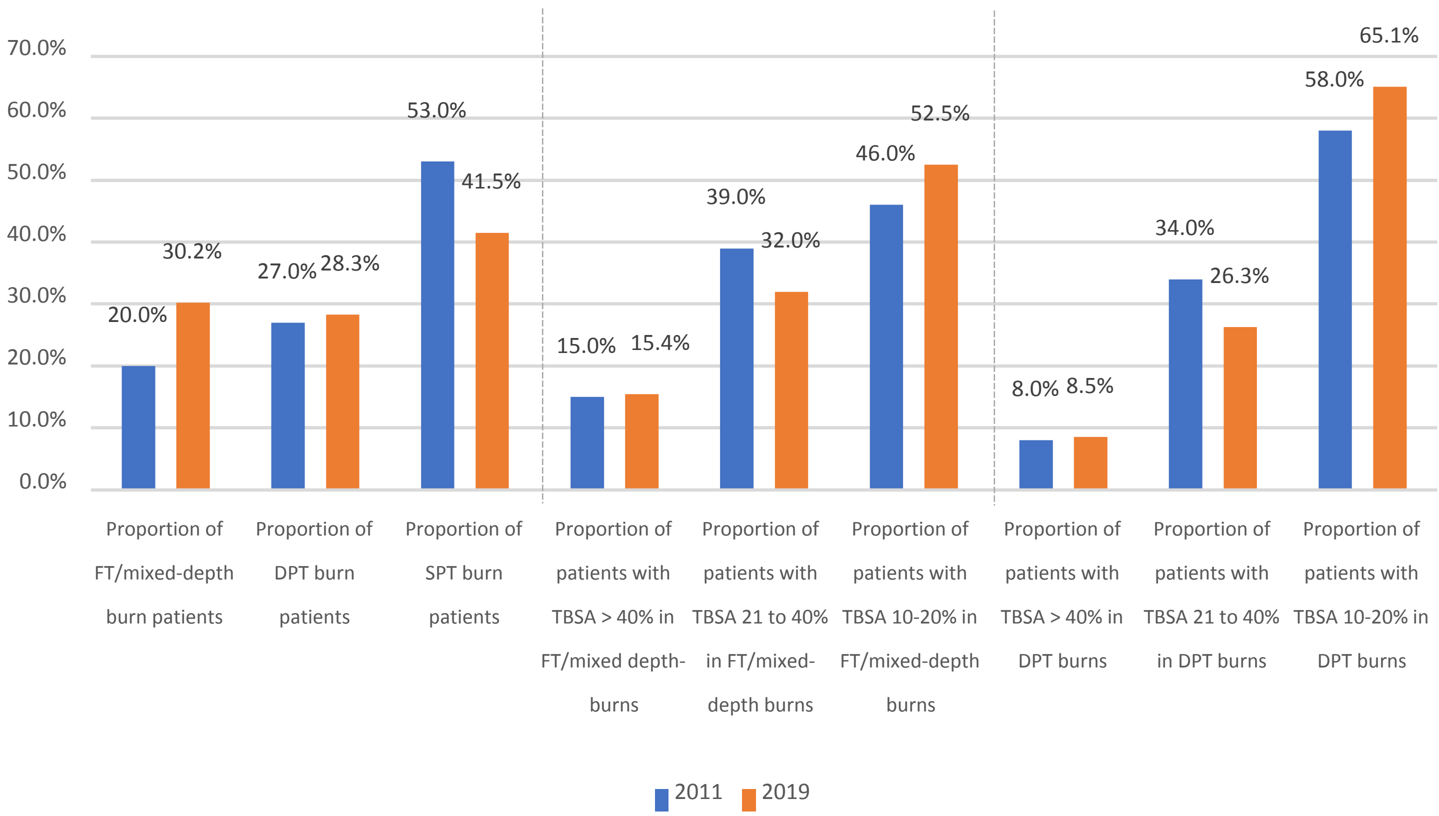
Average number of patients treated annually in a hypothetical burn center (n = 341) was used to estimate the budget impact. Patient characteristics for FT/mixed-depth and DPT burns such as wound distribution across TBSAs and average age were obtained from our survey. The same data for superficial partial-thickness (SPT) burns were obtained from the NBR data used in the original evaluation of ASCS with BEACON. Data such as gender, comorbidities were from NBR data consistent with CEM. The target CEM profiles described above highlight the range in outcomes across potential patient and burn types whereas the BIM considers the relative mix of TBSA ranges and burn depths. *Table 3*.

Results

Shift in trends of key model inputs: Survey (2019) vs NBR v8.0 (2002-2011)/physician survey (2017)

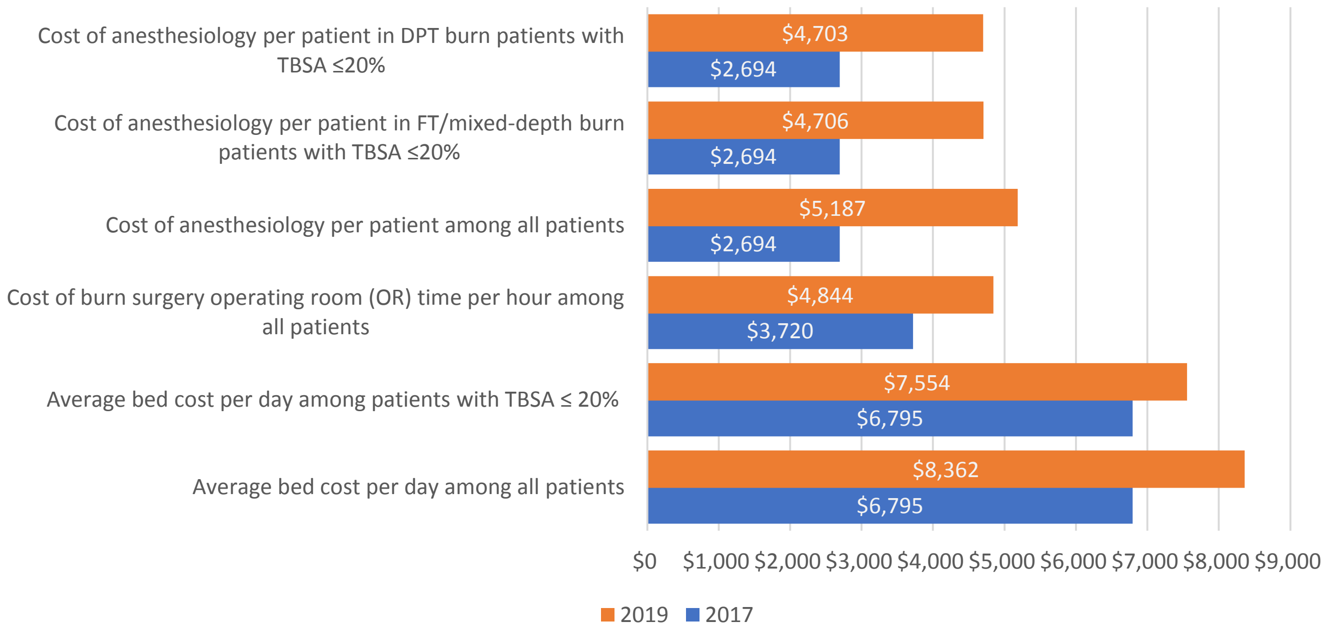
Based on the average patient distribution from the sample burn centers across burn depths, there is a significant increase in the proportion of severe burns treated in an inpatient setting (51% increase in FT/mixed-depth burns and 5% increase in DPT burns) compared to 2011. More SPT burns are now being treated in an outpatient setting (22% decrease in SPT burns treated inpatient compared to 2011). Survey data also showed that FT/ and DPT burns > 40% TBSA remained relatively stable since 2011 (from 15% to 15.5% in FT; from 8% to 8.6% in DPT). However, TBSA 21-40% decreased slightly (from 39% to 32% in FT; from 34% to 26% in DPT) and TBSA 10-20% burns have increased (from 46% to 52.5% in FT; from 58% to 65.12% in DPT) (Figure 1).

Figure 1. Trends in patient distribution



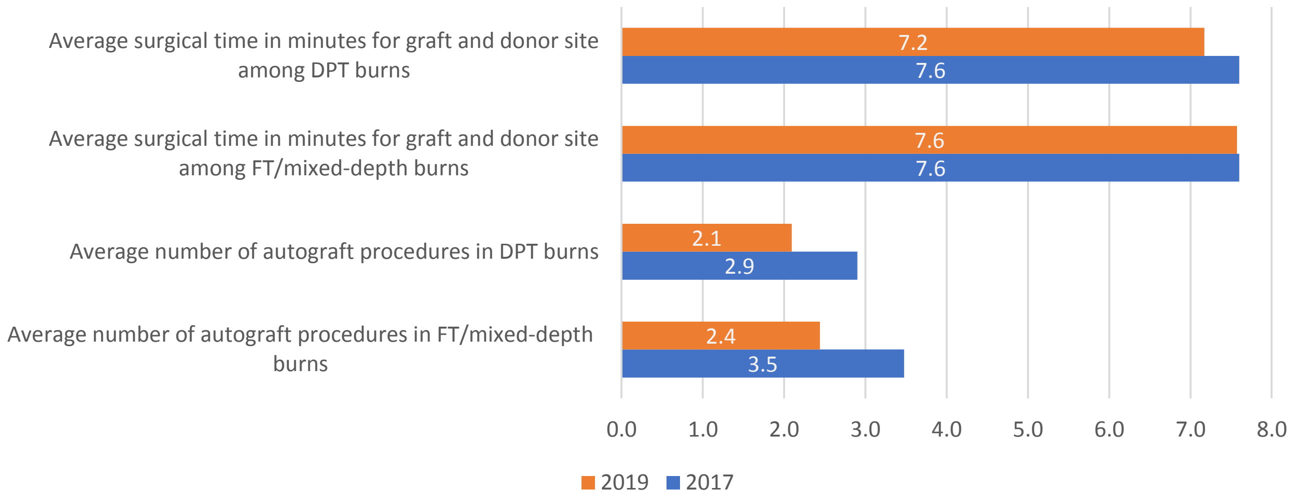
Since 2017, there has been an overall increase in inpatient bed cost per day (23% increase for all patients and 11% increase for patients with TBSA ≤20%), OR cost per hour (30% increase) and anesthesiology costs per patient (93% increase for all patients; 75% increase for FT/mixed-depth and DPT patients with TBSA ≤20%) (Figure 2).

Figure 2. Trends in costs



There is also a significant decreasing trend since 2017 in the average number of autograft procedures (30% decrease for FTburns and 28% decrease for DPT burns). The average surgical time for graft and donor site remained same in FT/ burns, but there is a slight decrease of 6% in average surgical time for graft and donor site among DPT burns (Figure 3). Detailed inputs for BEACON from NBR v8.0 and the 2017 cost data for comparison are available in a publication by Kowal S et al. [5]

Figure 3. Trends in resource use



Cost-effectiveness analysis

ASCS use was cost-saving for both FT/mixed-depth and DPT burns across all TBSA ranges. The major cost saving factor was the reduced number of autografting procedures due to ASCS use, which resulted in shorter LOS. LOS reductions can be attributed to the reduced need for donor skin harvesting and associated morbidities. In both, FT/ and DPT burns, cost-savings increased notably with increase in burn size due to overall reduction in the number of operations, dressing time, and associated costs compared to SOC. The number of SOC autograft procedures increased with larger burn size, leading to a greater difference in costs compared to ASCS. LOS was reduced for all patient profiles, but the relative shift in LOS was most favorable for large burns. The savings from LOS reduction with ASCS, relative to SOC estimates, was most favorable for DPT burns as well as for burns with TBSA of 40% or more, which led to greater reductions in LOS and associated inpatient costs for these patients. Notably, for FT/ burns of 40% TBSA, the projected reduction in LOS was almost 28 days (SOC, 59.4 days; ASCS, 31.3 days). Further, large relative LOS reductions were seen across all TBSA ranges for DPT, with ASCS-reductions in LOS increasing along with increases in TBSA percentages. Savings due to ASCS were higher in DPT burns relative to FT/mixed-depth burns with 10% (24.6% vs 1.0%), 20% (25.5% vs 3.7%), 30% (28.4% vs 4.9%) TBSA due to fewer autograft procedures and LOS days. However, savings due to ASCS were slightly lower in DPT burns with 40% TBSA (40.5%) compared to FT/mixed-depth burns (42.9%) mainly due to higher incremental difference in LOS and graft surgeries in FT burns.

Across all patient profiles, the use of ASCS translates to over 20% reduction in rehabilitation costs (savings ranged from $1,375 in 10% TBSA to $3,302 in 40% TBSA FT burns and from $,1,443 in 10% TBSA to $2,727 in 40% TBSA DPT burns), due to a reduced proportion of patients requiring surgical procedures for contracture release and reduced number of days as inpatients with physical therapy and occupational therapy visits. CEM results are reported in Table 4.

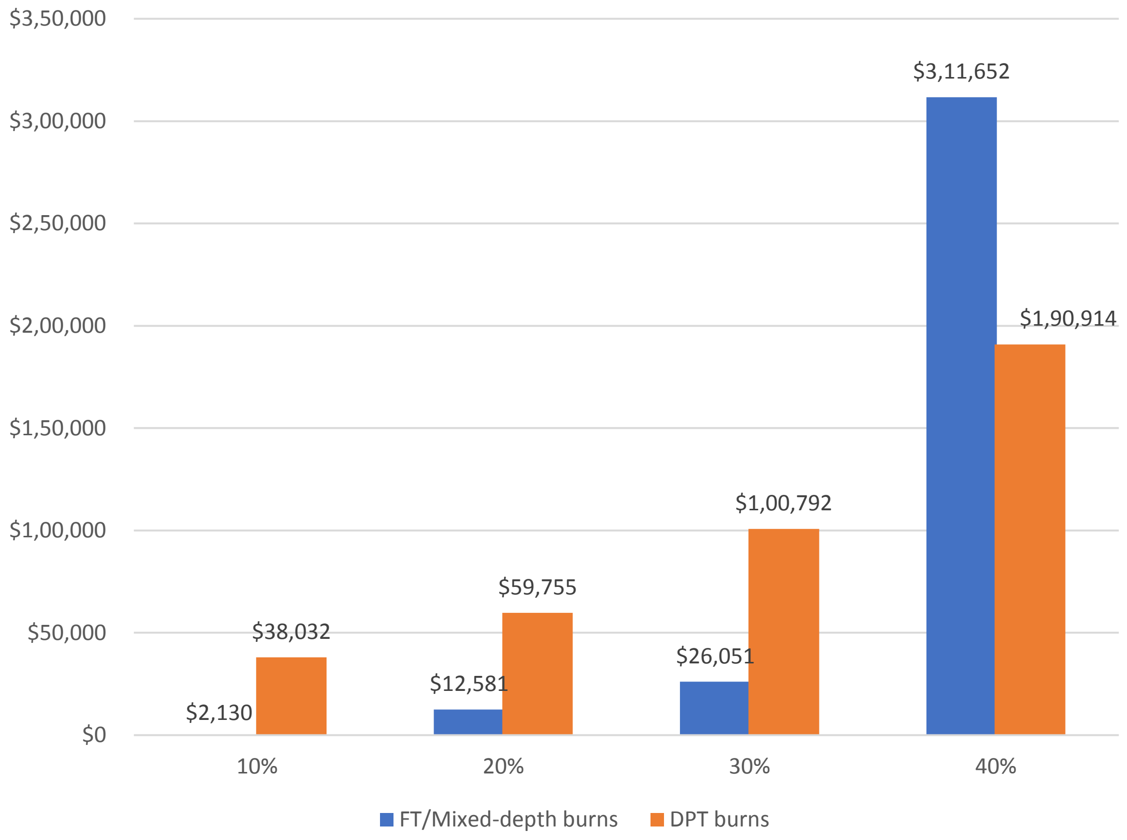
Table 4. Cost effectiveness model (CEM) results by depth and TBSA

Burn depth	TBSA	Results measure	SOC	ASCS	Difference $/days (%)
Full-thickness/ mixed-depth thickness	10%	Total Costs	$203,043	$200,913	-$2,130 (-1.0%)
		Total LOS	21.2	20.8	-0.42 (-2.0%)
		No. Grafting Surgeries	1.2	1.0	-0.2 (-16.6%)
	20%	Total Costs	$341,571	$328,990	-$12,581 (-3.7%)
		Total LOS	32.4	31.8	-0.65 (-2.0%)
		No. Grafting Surgeries	2.2	1.0	-1.2 (-53.9%)
	30%	Total Costs	$534,617	$508,566	-$26,051 (-4.9%)
		Total LOS	45.0	44.1	-0.9 (-2.0%)
		No. Grafting Surgeries	2.6	1.0	-1.6 (-61.4%)
	40%	Total Costs	$726,795	$415,144	-$311,652 (-42.9%)
		Total LOS	59.4	31.3	-28.17 (-47.4%)
		No. Grafting Surgeries	3.8	1.0	-2.8 (-73.8%)
Deep-partial thickness	10%	Total Costs	$154,518	$116,486	-$38,032 (-24.6%)
		Total LOS	15.6	10.9	-4.69 (-30.0%)
		No. Grafting Surgeries	1.1	1.0	-0.1 (-12.1%)
	20%	Total Costs	$234,740	$174,985	-$59,755 (-25.5%)
		Total LOS	21.2	14.9	-6.36 (-30.0%)
		No. Grafting Surgeries	1.8	1.0	-0.8 (-45.1%)
	30%	Total Costs	$354,584	$253,792	-$100,792 (-28.4%)
		Total LOS	28.1	19.7	-8.44 (-30.0%)
		No. Grafting Surgeries	2.4	1.0	-1.4 (-58.7%)
	40%	Total Costs	$471,773	$280,859	-$190,914 (-40.5%)
		Total LOS	37.0	19.5	-17.55 (-47.4%)
		No. Grafting Surgeries	3.0	1.0	-2.0 (-66.7%)

Note that only differential grafting surgeries are shown in this table, as treatment phases preceding definitive closure were assumed non-differential. (Please refer to Table 1 in Kowal S et al., for information on number of debridement and excision procedures.)

The overall findings were similar to the Kowal S et al publication with slightly lower cost-savings using the latest real-world survey data due to the overall reduction in number of SOC autograft procedures compared to 2011. Savings due to ASCS across burn depths and TBSA ranges are shown in Figure 4.

Figure 4. Savings due to ASCS across all burn depths and TBSA ranges



For all patient profiles, the use of ASCS consistently led to cost savings when varying model inputs across expected high and low ranges which demonstrates that model results remain robust across expected uncertainties or variations in individual model parameters. All OWSA diagrams show change in total inpatient cost, with negative numbers indicating savings relative to SOC and positive numbers indicating increases in cost relative to SOC. OWSA diagrams can be found in appendix Figures A.1-A.8.

Budget impact analysis

By aggregating all patient profiles to view results for a hypothetical burn center that is representative of national trends in burn depth and TBSA and assuming 100% accuracy in depth diagnosis, the use of ASCS is expected to reduce overall costs by an estimated $15.8M for the center (with an average of 341 patients treated annually) and $79.6K (17.4% reduction) per patient, on average compared to $6.8M for 200 patients and $34K per patient using NBR data as reported in Kowal S et al publication . Given the model's base-case scenario which assumes no difference in burn care prior to definitive closure (e.g., wound assessment, debridement or excision), costs for the early phases of burn care are unchanged by ASCS use. At the burn center level, reductions in costs are expected to be most significant for definitive closure activities, largely driven by the reduction in the number and duration of procedures performed for definitive closure, decreases in LOS, and reductions in rehabilitation needs. The reduction in donor skin harvest requirements and associated morbidities from ASCS use was a significant contributor to LOS decreases. BIM results are reported in

Table 5. Budget impact model (BIM) results

Costs by category (341 patients)	Standard of care	ASCS integrated into standard of care	Difference $ (%)
Wound assessment	$843,529	$843,529	$0 (0.0%)
Debridement/Excision	$5,655,361	$5,655,361	$0 (0.0%)
Temporary coverage	$0	$0	$0 (0.0%)
Definitive closure	$12,116,503	$9,336,092	-$2,790,411 (-23.0%)
Rehabilitation	$1,634,459	$1,267,647	-$366,812 (-22.4%)
LOS	$68,849,502	$56,996,179	-$11,853,324 (-17.2%)
Other[a]	$1,836,542	$1,836,542	$0 (0.0%)
Total costs	$90,935,896	$75,096,331	-$15,839,565 (-17.4%)
Average cost per patient (FT and DPT burns only)	$456,964	$377,368	$79,596 (-17.4%)

[a]Other includes: costs for anesthesia and escharotomy

Discussion

The previously developed BEACON model evaluated the cost-effectiveness and burn center budget-impact of the use of ASCS compared to conventional STSG for the management of inpatient burns using NBR data from 2002-2011 and cost data from 2017. Although the NBR is a large repository of useful data from most US burn centers, one of its limitations includes a time delay with respect to data analysis which may defer insights on new interventions and constrain the utility of the NBR to burn centers for benchmarking performance. Therefore, given new trends in burn care treatment at individual burn centers, this study was conducted to reassess the potential economic impact of ASCS. A survey administered to 10% sample of U.S. burn centers to provide real-world data updates to supplement the NBR by adding important granularity and transparency on detailed patterns for patient outcomes. Using the 2019 burn center survey data, we provide updated values relative to burn care practices for estimating of the value of new interventions relative to SOC given current trends in treatment patterns and patient demographics. Comparison of key clinical, cost and resource utilization inputs relative to the NBR demonstrate a significant increase in the proportion of severe burns treated in an inpatient setting compared to 2011. Results indicate an overall increase in costs and a decreasing trend in the resource use since 2017, and higher costs also create an opportunity for greater savings as a benefit of adopting a cost-saving intervention such as ASCS. The impact of ASCS use on patient LOS, number and duration of definitive closure procedures, inpatient resource utilization, and the estimated cost impact to a burn center for treatment of severe burns in the U.S. was shown to produce favorable cost savings across all patient profiles (by burn depth and TBSA) compared to SOC. The major cost driver is the reduced number surgical procedures due to ASCS use which is due to the reduced need for donor skin. In both, FTand DPT burns, cost-savings increased notably with burn size due to the overall reduction in the number of operations, dressing time, and associated costs compared to SOC. OWSA results confirm that model results remain robust across expected uncertainties or variations in individual model parameters. Leveraging the individual patient results from the CEM, the BIM considered the mix of patients and burn characteristics expected to present at a typical U.S. burn center annually. Considering the budget across 341 patients distributed across patient profiles consistent with the US severe (TBSA 10%+) burn population (survivors only), the BIM found that changing the current treatment strategy to ASCS would be cost saving to a burn center overall. The findings of this study illustrate how the benefits of ASCS use, which include reduced donor skin site harvesting and thus a reduced number of grafting procedures and a faster healing time, can translate into economic savings to the burn center [15,17]. The overall study findings corroborate the original ASCS evaluation in the BEACON model which also reported cost savings due to ASCS in comparison to SOC using NBR v8.0 data[5]. Currently, there are no other studies available which have conducted an economic evaluation of novel interventions used for definitive closure in inpatient burn care treatment.

This study provides a more realistic and up-to-date economic value assessment of ASCS using current real-world data in the treatment of burn care as inpatient treatment patterns for burns can vary widely in the U.S. at the burn center level or even by surgeon. It also confirms the opportunity to use the BEACON model to assess any future novel interventions. This evaluation highlights the significance of obtaining current patient characteristics, burn features and surgeon practices as each impacts important steps in burn wound management, ranging from the size of wound excised, amount of donor-skin used, number of autograft surgeries, timing of excision and autograft, type of wound coverage, facility cost structure, daily cost per bed, cost per hour of OR time, as well as timing for patient discharge and outpatient follow-up. In addition, the study also helps to address challenges in understanding the likely impact of a new treatment alternative in terms of costs, provider practices and patient outcomes. This analysis also provides an example of how real-world data coupled with NBR data facilitates a more effective evaluation of new and existing technologies and methods in the burn care pathway in order to improve our understanding of the real-world evidence of treatment options in burn care. These findings support the ABA's goal of improving the quality, outcomes, patient care, effectiveness and cost of burn care through the collection and exchange of information.

As with any economic model, this study is subject to limitations that should be considered when interpreting results. First, costs and resource use were derived from a survey of burn care surgeons, which represent average costs as reported by the burn centers. Second, several assumptions were made for transparency in the use of the BEACON economic model, (for example individual unit costs and temporary coverage interventions were not considered in detail, and the model also assumes correct diagnosis when determining pathways for a diagnosed burn; please see Kowal S et al publication for detailed assumptions). Where data were unavailable from burn centers, default values from original ASCS evaluation were used. While the above limitations exist, best-practice modeling methods were considered, and key assumptions were validated by burn surgeons to ensure that the analytic conclusions are methodologically sound and have practical application for the burn community. Lastly, the topography of burn care has evolved more briskly in the recent years with occasional momentous new developments making any health economic evaluation simply a photograph in time and potentially misrepresenting changes in practices.

Conclusion

This survey research to obtain the latest real-world data for input into the BEACON model re-evaluates the impact of ASCS on burn care outcomes and costs for severe burns in the US. Inpatient burn management for individual patient profiles and for burn centers is estimated. Given the changes in current standard of care practice patterns and the distribution of patient characteristics seen nationally, BEACON demonstrates the impact of ASCS use in reducing costs associated with the current treatment of severe burns (10%+ TBSA), particularly in large burns and in burns of indeterminate depth. The cost reductions are due to decreasing LOS, reducing the number of procedures required to close the burn wound, decreasing the donor site size and associated donor site wound care, and reducing the number of downstream contracture procedures. Serial use of real-world data as we have demonstrated has the potential to produce a new benchmark from real-world evidence and to improve our understanding and application of best practices for the best outcomes.

Conflict of Interest:

- This study was sponsored by Avita Medical, Valencia, CA. IQVIA received funding from Avita Medical to assist with survey development, data analyses, and manuscript preparation. C Ferrufino, S Kowal and P Vadagam are employees of IQVIA, Inc, which provides consulting and other research services to biopharmaceutical companies. J Sparks and T Walsh are employees and shareholders of Avita Medical.
- Jeffrey E. Carter, MD is a consultant with SpectralMD, Inc. and Avita Medical, Ltd. Considering the association with Avita Medical, In lieu of compensation, donations are made to a local 501(c)(3) charity supporting local burn prevention, outreach, education, and survivor programs. Dr. Carter is a stockholder of Permeaderm Inc. & SpectralMD Inc. Dr. Carter has research supported by Sprit of Charity Foundation Burn Research Fund.
- H Amani, MD is a consultant for Avita Medical and has received honoraria for consulting services.
- Damien Carter, MD has no conflicts to declare,
- Kevin N. Foster MD, MBA, FACS is the PI for research study on studies sponsored by the American Burn Association (ABRUPT), Atox-Bio, BARDA, Polynovo Biomaterials, Mallinckrodt, and Mediwound. Dr. Foster is a consultant and form PI for Baxter. Dr. Foster is a consutant for Integra.
- John A. Griswold, MD, FACS has no conflicts to declare.
- William L. Hickerson, MD, FACS is a consultant with Avita Medical, Vericel, and Avadim Health, Inc. Dr. Hickerson is a stockholder of PermeaDerm.
- James Hill Holmes IV, MD disclosures include equity positions in Abbott Labs, AbbVie, Change Healthcare, & Imbed Biosciences. Dr. Holmes is a consultant for Mallinckrodt and Avita Medical.
- Samuel Jones, MD, FACS has no conflicts to declare.
- Anjay Khandelwal, MD, FACS, FICS is an advisor to Avita Medical.
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UMCNO Burn Center, New Orleans LA
University of California San Francisco Fresno, Fresno CA
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Wake Forest Baptist Burn Center, Winston-Salem NC

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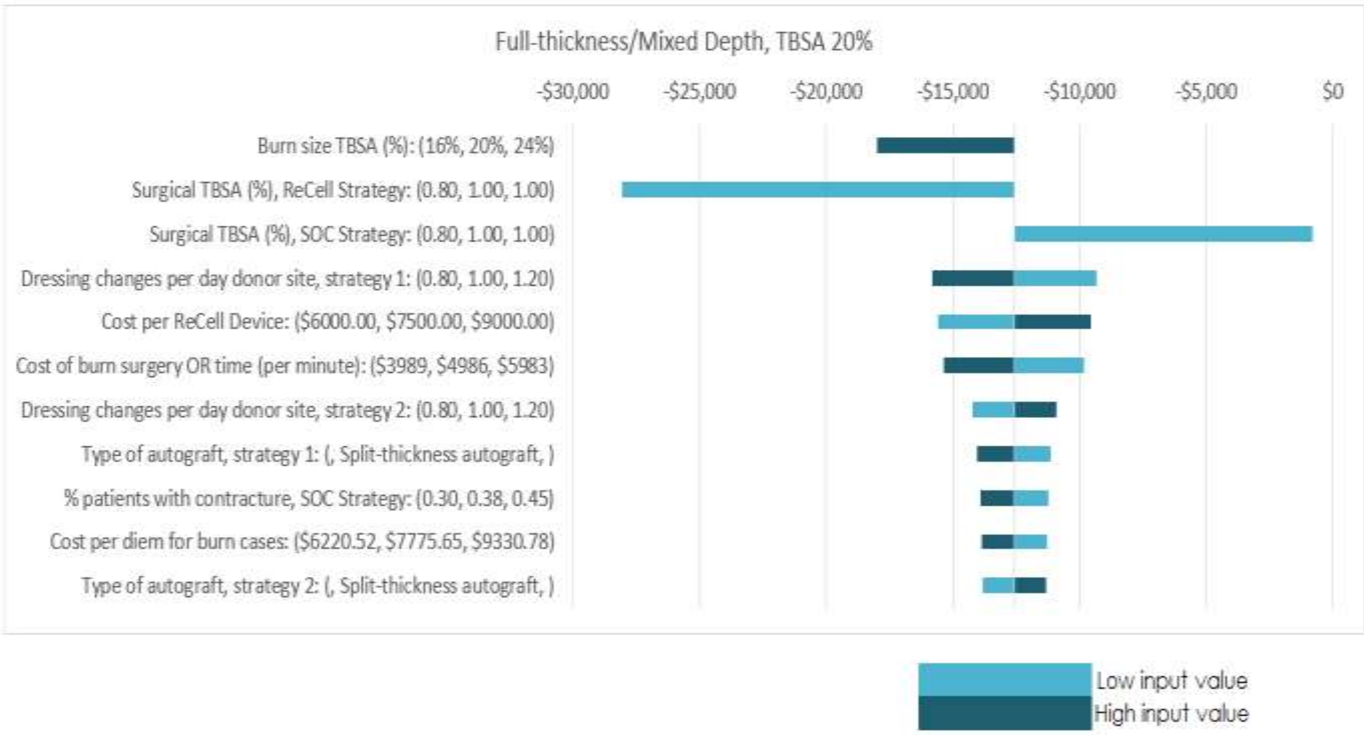
Appendix

Sensitivity analyses based on NBR predictive equations methods

Figure A.1. OWSA results FT/Mixed 10%-NBR scenario

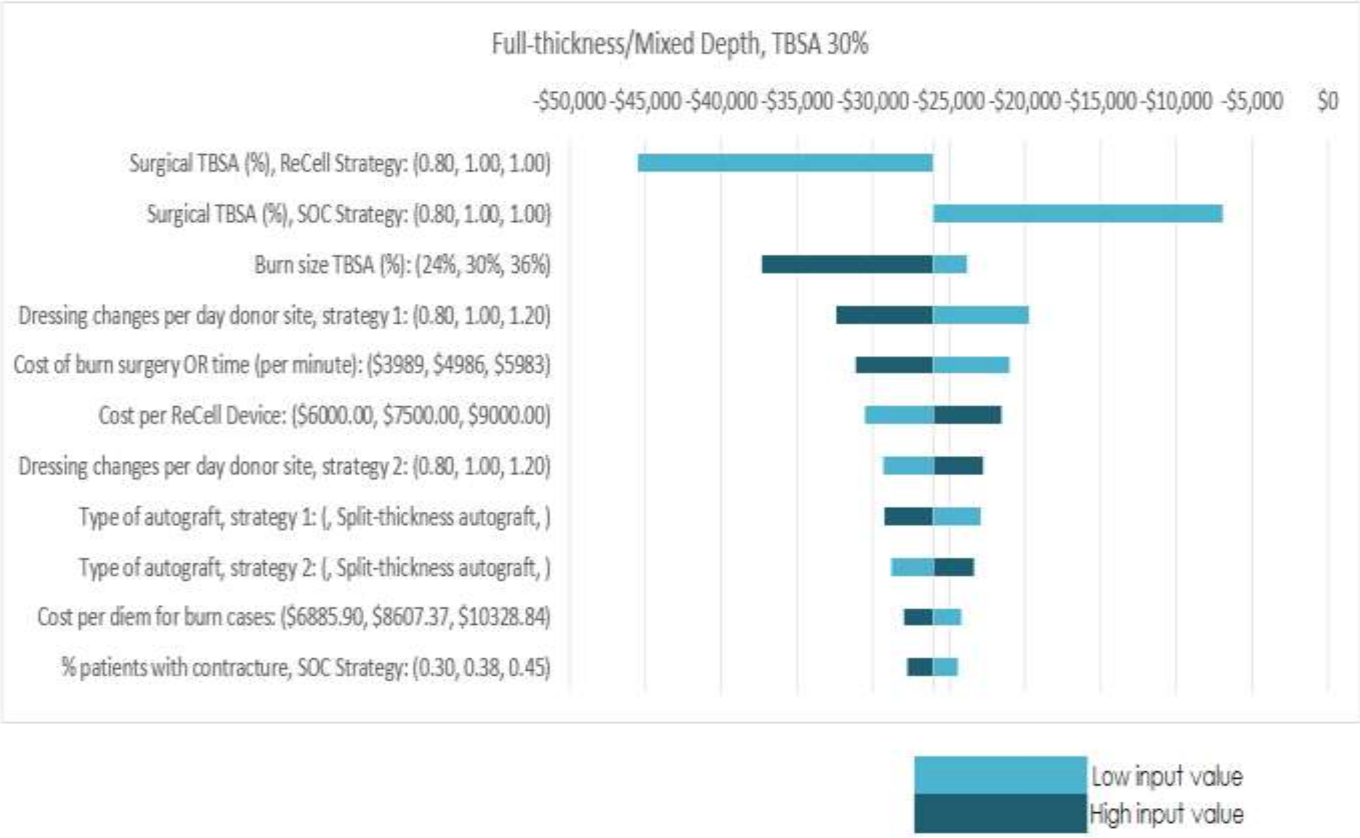
Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.2. OWSA results FT/Mixed 20%- NBR scenario



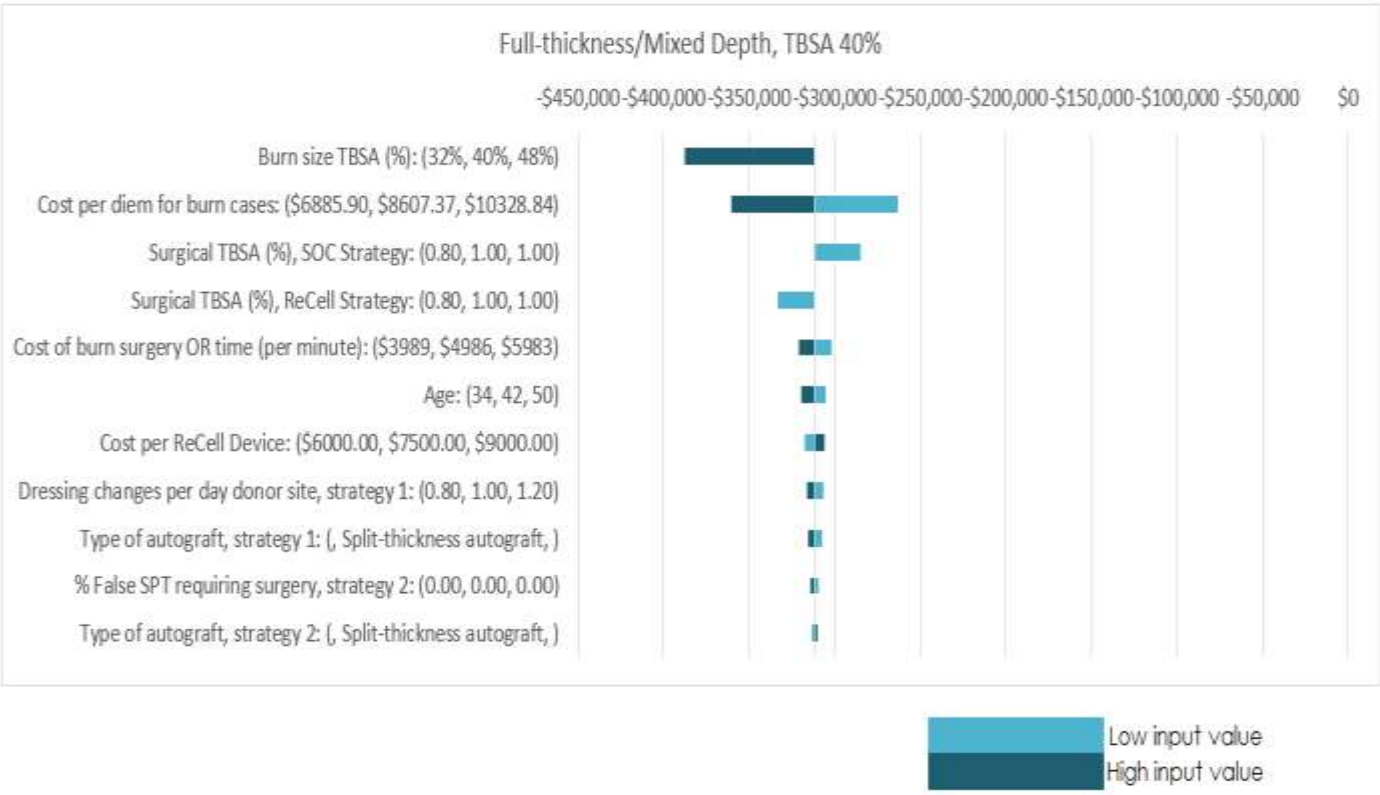
Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.3. OWSA results FT/Mixed 30%- NBR scenario



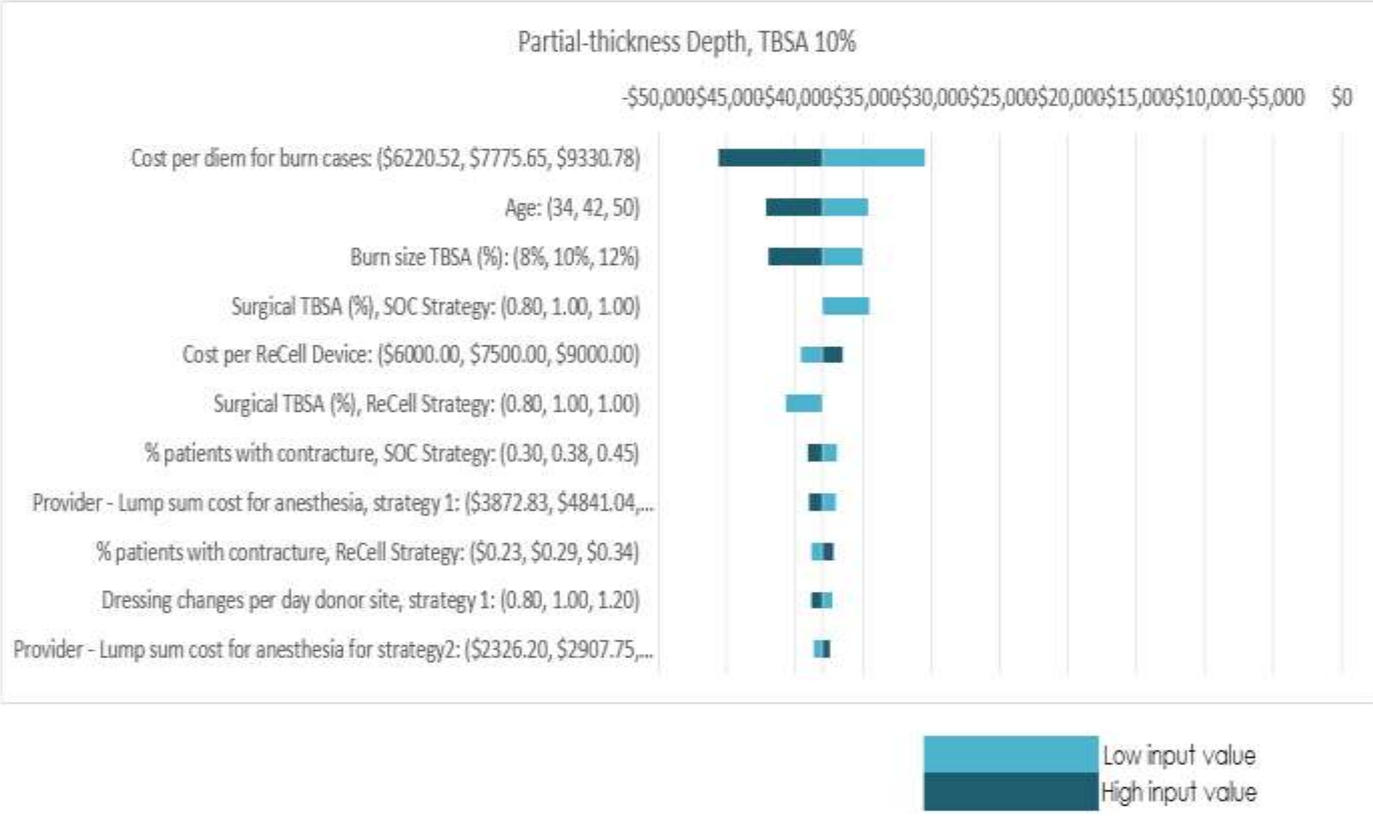
Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.4. OWSA results FT/Mixed 40%- NBR scenario



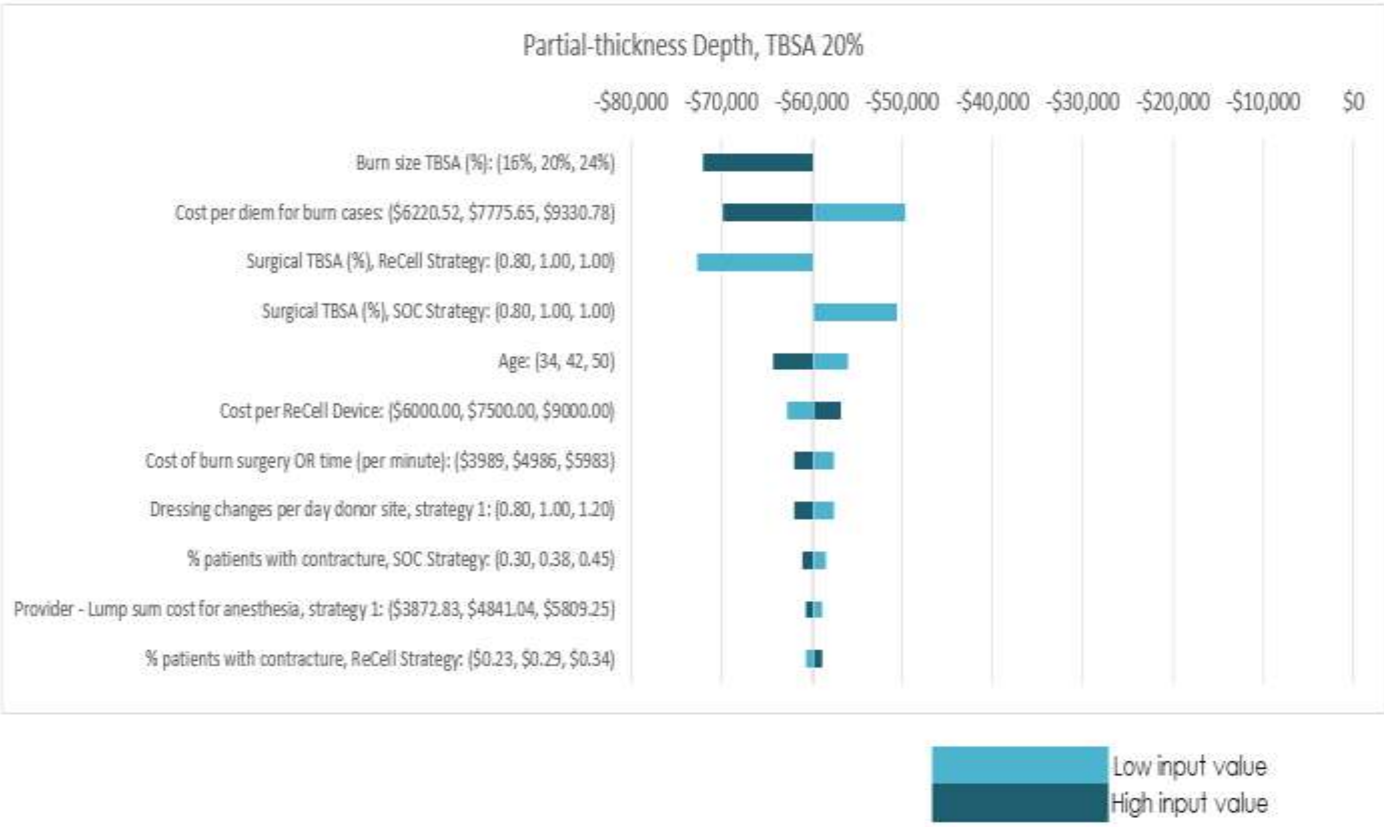
Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.5. OWSA results DPT 10%- NBR scenario



Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.6. OWSA results DPT 20%- NBR scenario

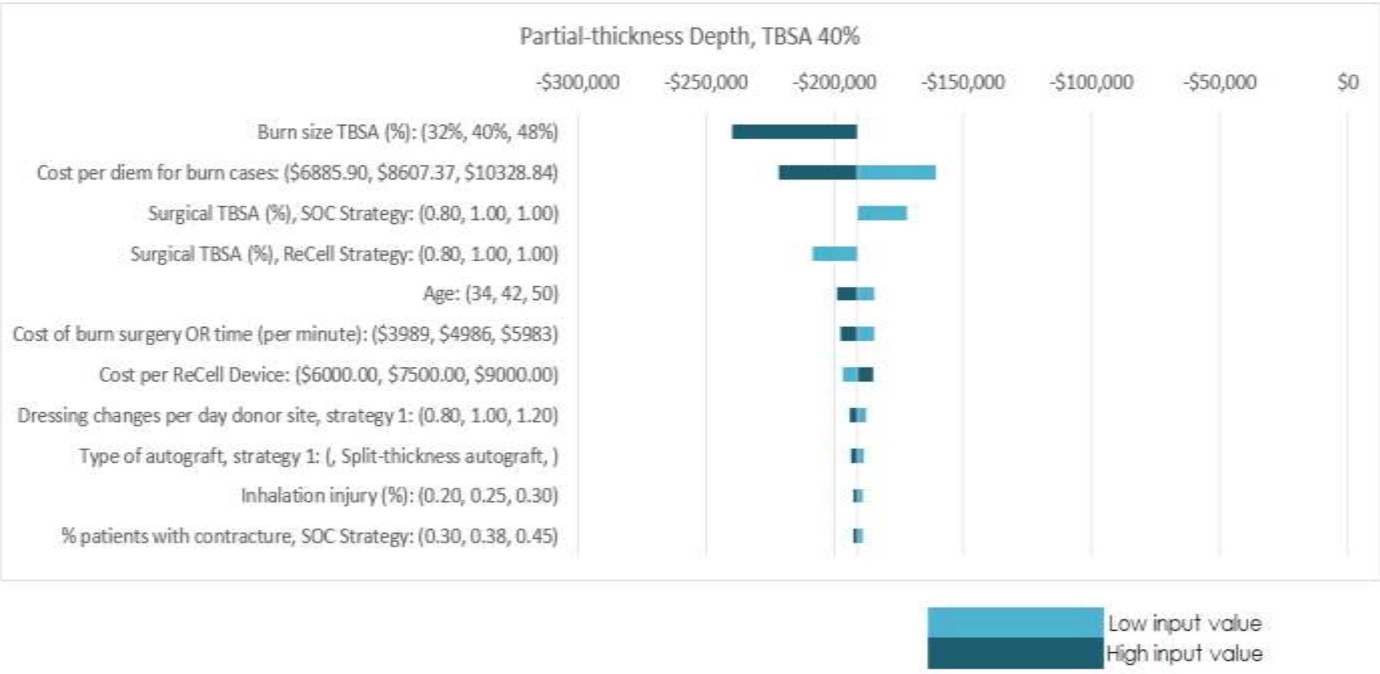


Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.7. OWSA results DPT 30%- NBR scenario

Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

Figure A.8. OWSA results DPT 40%- NBR scenario



Model results are cost savings across variations in all input parameters, suggesting that the model result of cost savings is consistent.

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