Article

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Cost-Effectiveness of Bariatric Surgery, Glucagon-Like Peptide-1 Receptor Agonists, Intensive Lifestyle Therapy, and Liberal Waitlisting in Adults With Obesity Undergoing Kidney Transplant Evaluation: A United States Decision-Analytic Study Using 2015–2023 Public Evidence

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ABSTRACT

Background: Obesity remains a major barrier to kidney transplantation despite the survival benefit of transplantation over dialysis. This study evaluated the cost-effectiveness of four strategies for adults with end-stage kidney disease and obesity undergoing kidney transplant evaluation in the United States. **Methods:** A state-transition Markov cohort model was developed from the health-sector perspective. Four strategies were compared: liberal waitlisting, bariatric surgery, glucagon-like peptide-1 receptor agonist therapy, and intensive lifestyle management. Inputs were drawn from publicly available evidence published between 2015 and 2023. The primary outcome was the incremental cost-effectiveness ratio per quality-adjusted life-year gained. **Results:** Over a 10-year horizon, liberal waitlisting had the lowest discounted cost ($246,100), whereas bariatric surgery had the highest discounted effectiveness (4.891 quality-adjusted life-years). Compared with liberal waitlisting, bariatric surgery increased cost by $35,400 and effectiveness by 0.079 quality-adjusted life-years, yielding an incremental cost-effectiveness ratio of $448,101 per quality-adjusted life-year gained, above conventional U.S. willingness-to-pay thresholds. Glucagon-like peptide-1 receptor agonist therapy improved outcomes versus lifestyle management but remained less efficient than bariatric surgery. **Conclusions:** Liberal waitlisting was the economically preferred strategy in the 10-year base-case analysis. Bariatric surgery produced the greatest health gain but was not cost-effective relative to liberal waitlisting, while glucagon-like peptide-1 receptor agonist therapy improved on lifestyle management without surpassing the other strategies in overall economic performance.

KEYWORDS: kidney transplantation; obesity; bariatric surgery; glucagon-like peptide-1 receptor agonists; cost-effectiveness; decision analysis; Markov model

1 Introduction

Obesity and end-stage kidney disease increasingly intersect in contemporary transplant practice in the United States, where obesity has important implications for incident dialysis populations and transplant access [1]. These access barriers matter because kidney transplantation, when feasible, confers substantial survival and quality-of-life benefits relative to continued dialysis [2]. At the same time, obesity is associated with perioperative and posttransplant complications, including delayed graft

function, wound morbidity, and inferior graft outcomes in selected populations [3]. The resulting tension between transplant access and perioperative risk has made obesity one of the most difficult issues in kidney transplant candidate evaluation.

The clinical and policy context changed substantially during 2015–2023. Contemporary registry reports documented ongoing growth in kidney transplant activity in the United States while also showing that many candidates continue to spend prolonged periods on the waiting list [4]. The 2020 Kidney Disease: Improving Global Outcomes guideline advised that transplant candidates should not be excluded solely because of obesity [5]. The subsequent ERA-DESCARTES guideline likewise emphasized individualized assessment, recognition of center-level variation, and selective use of bariatric surgery in suitable patients [6]. These developments reflect increasing concern that prolonged waiting for weight loss may expose candidates to the considerable mortality and morbidity burden of continued dialysis without guaranteeing eventual transplantation.

Management options have also expanded. Longer-term surgical evidence has shown durable weight loss after bariatric procedures [7]. At the same time, perioperative risks remain relevant in dialysis-dependent populations [8]. In parallel, glucagon-like peptide-1 receptor agonists emerged as highly effective anti-obesity therapies after the publication of pivotal semaglutide trial data [9]. Subsequent tirzepatide trial results further strengthened the pharmacologic evidence base for obesity treatment [10]. The SELECT trial then increased interest in semaglutide by demonstrating cardiovascular benefit in adults with overweight or obesity and established cardiovascular disease without diabetes [11]. These therapeutic advances raise an important question for transplant policy and clinical practice: whether modern weight-loss options alter the comparative value of liberal waitlisting, bariatric surgery, pharmacologic therapy, or lifestyle management for candidates with obesity.

The present study addressed this question using a decision-analytic framework based exclusively on public evidence published between 2015 and 2023. The objective was to compare the cost-effectiveness of liberal waitlisting, bariatric surgery, glucagon-like peptide-1 receptor agonist therapy, and intensive lifestyle management in adults with obesity undergoing kidney transplant evaluation in the United States. The central hypothesis was that liberal waitlisting and bariatric surgery would remain preferable to prolonged lifestyle-only delay, while pharmacologic therapy would improve outcomes relative to lifestyle care but remain constrained by current costs and by time-to-transplant considerations.

2 Methods

2.1 Study design and analytic perspective

A state-transition Markov cohort model was constructed to evaluate the clinical and economic consequences of four obesity-management and transplant-access strategies for adults with dialysis-dependent end-stage kidney disease. The analysis was performed from the health-sector perspective. Annual cycles were used, and costs and health outcomes were discounted at 3% per year. The principal and only reported time horizon for the present analysis was 10 years.

2.2 Target population

The hypothetical cohort consisted of adults with dialysis-dependent end-stage kidney disease and obesity severe enough to create a barrier to waitlisting or transplantation at centers using restrictive body mass index thresholds. The base-case patient was assumed to have a mean age of 50 years and to require approximately 15% total body weight loss to move from obesity-restricted candidacy to active waitlisting under the nonliberal strategies. This base-case framing was chosen because it reflects the practical reality that many transplant centers use body mass index thresholds in the range of 35–45 kg/m^2 when evaluating transplant eligibility.

2.3 Strategies compared

Four strategies were evaluated.

The first strategy was *liberal waitlisting*, in which obesity was not treated as an automatic barrier to waitlisting or transplantation. Patients entered the waiting-list pathway immediately and were exposed to obesity-associated perioperative and posttransplant risks.

The second strategy was *bariatric surgery before listing*. Patients underwent bariatric surgery as a transplant-enabling intervention and were listed if sufficient weight loss was achieved. The model

incorporated procedure-related mortality, major complications, durable weight reduction, and the potential for improved posttransplant risk after successful weight loss.

The third strategy was *glucagon-like peptide-1 receptor agonist therapy*. This arm represented modern high-efficacy anti-obesity pharmacotherapy informed by semaglutide- and tirzepatide-based evidence. Patients were listed after achieving the required weight-loss threshold, and long-term treatment costs were applied while therapy remained active.

The fourth strategy was *intensive lifestyle management*, representing diet, physical activity, and behavioral intervention without surgery or incretin-based pharmacotherapy. This arm was included because lifestyle intervention remains the most common practical recommendation made to many transplant candidates with obesity.

2.4 Model structure

Patients entered the model in the state of dialysis-dependent end-stage kidney disease at the time of transplant evaluation. Depending on strategy assignment, they then transitioned among the following states: dialysis without listing, active waitlisting, transplantation in the first posttransplant year, maintenance transplantation beyond year 1, graft failure with return to dialysis, relisting after graft failure, and death. Death was modeled as an absorbing state.

Under the three weight-loss strategies, patients were assumed to require successful achievement of the target weight-loss threshold before entering the waitlist state. Under the liberal strategy, candidates proceeded directly to waitlisting without mandatory pretransplant weight reduction. Once transplanted, patients could experience delayed graft function, wound complications, incisional hernia, maintenance graft survival, graft failure, return to dialysis, and death. Patients with graft failure could be relisted according to an annual relisting probability.

2.5 Evidence sources

Model inputs were derived from publicly available sources published from 2015 through 2023. Contemporary transplant activity and waiting-list context were informed by the OPTN/SRTR 2023 Annual Data Report. Broader end-stage kidney disease population and expenditure data were informed by the USRDS 2023 Annual Data Report. Candidate evaluation and obesity-management assumptions were informed by the 2020 KDIGO guideline and the 2022 ERA-DESCARTES clinical practice guideline on obesity in kidney transplant candidates and recipients. Weight-loss efficacy for pharmacologic therapy was informed by randomized trials of semaglutide and tirzepatide in obesity, while cardiovascular benefit was informed by the SELECT trial. Bariatric-surgery risk and long-term outcome assumptions were informed by national analyses in end-stage kidney disease and by longer-term surgical follow-up studies. Obesity-associated transplant risks were informed by systematic review, meta-analysis, and large observational transplant studies.

2.6 Clinical input parameters

Table 1 summarizes the principal model inputs used in the base case. Because this study was based on public rather than proprietary registry files, some transition probabilities were calibrated to contemporary U.S. patterns described in national reports rather than directly estimated from patient-level source data.

Table 1. Base-case model inputs

Parameter	Base-case value	Source basis
Mean age at evaluation	50 years	Contemporary transplant candidate modeling assumption
Target total body weight loss for nonliberal strategies	15%	Contemporary transplant-access threshold assumption
Probability of achieving target with lifestyle therapy	12%	Structured lifestyle evidence and conservative calibration
Probability of achieving target with GLP-1RA therapy	75%	STEP and SURMOUNT-1 trials
Probability of achieving target with bariatric surgery	88%	Bariatric surgery literature and durability studies
30-day mortality after bariatric surgery	1.2%	ESRD bariatric-surgery risk studies
Major complication probability after bariatric surgery	9.5%	ESRD bariatric-surgery risk studies
Annual probability of transplant from waitlist	18.5%	Contemporary U.S. calibration using OPTN/SRTR patterns
Annual waitlist removal probability	6.2%	Contemporary U.S. calibration using OPTN/SRTR patterns
Annual graft failure probability	3.8%	Contemporary transplant outcome calibration
Annual relisting probability after graft failure	14.0%	Model calibration
Annual GLP-1RA discontinuation probability	11.0%	Long-term adherence uncertainty scenario
Delayed graft function probability among obese recipients	28.0%	Obesity-associated transplant complication literature
Wound complication probability among obese recipients	15.0%	Obesity-associated transplant complication literature
Incisional hernia probability among obese recipients	12.0%	Obesity-associated transplant complication literature
Annual dialysis cost	$94,200	USRDS-based costing framework
First-year transplant cost	$163,000	USRDS-based costing framework
Annual maintenance transplant cost	$35,400	USRDS-based costing framework
Annual GLP-1RA cost	$13,800	Contemporary U.S. pharmacotherapy cost assumption
One-time bariatric surgery cost	$31,500	Contemporary U.S. bariatric cost assumption
Utility of dialysis	0.68	Published kidney failure utility literature
Utility of functioning transplant	0.82	Published kidney transplant utility literature
Obesity-related annual disutility	-0.05	Published obesity utility literature
Discount rate	3%	Standard cost-effectiveness practice

2.7 Costs

Direct medical costs included dialysis, transplantation, maintenance transplant care, graft-failure events, bariatric surgery, glucagon-like peptide-1 receptor agonist therapy, obesity-related medical spending, and major early posttransplant complications. Costs were represented in 2023 U.S. dollars. The primary costing framework was anchored to contemporary U.S. spending patterns reported by the USRDS, supplemented where necessary by public obesity-treatment economic literature and standard U.S. cost references.

2.8 Utilities and effectiveness

Health outcomes were expressed as quality-adjusted life-years. Dialysis carried lower baseline utility than successful transplantation. Obesity imposed an additional disutility. Bariatric surgery carried a brief perioperative decrement in quality of life, while major complications imposed further temporary disutility. The primary economic outcome was the incremental cost-effectiveness ratio per quality-adjusted life-year gained.

2.9 Base-case and scenario analyses

The base-case analysis compared all four strategies over a 10-year horizon. No additional time-horizon or threshold analyses are reported in the present manuscript.

2.10 Sensitivity analysis

One-way deterministic sensitivity analyses were planned for all influential parameters, including bariatric-surgery cost, bariatric-surgery efficacy, annual glucagon-like peptide-1 receptor agonist cost, annual transplant probability from the waitlist, obesity-related posttransplant penalty, and the utility increment associated with transplantation. A probabilistic sensitivity analysis using simultaneous parameter variation from prespecified distributions was also planned to estimate the probability that each strategy would be preferred across a range of willingness-to-pay thresholds.

3 Results

3.1 Base-case clinical and economic outcomes

In the base-case analysis over a 10-year horizon, liberal waitlisting yielded the lowest discounted mean cost at $246,100 per patient, whereas bariatric surgery produced the highest discounted effectiveness at 4.891 quality-adjusted life-years. Glucagon-like peptide-1 receptor agonist therapy generated greater effectiveness than lifestyle management but remained less efficient than bariatric surgery under contemporary annual drug-cost assumptions. Intensive lifestyle management alone produced the lowest probability of receiving transplantation and the lowest long-term quality-adjusted survival.

The modeled 10-year patient survival was 56.2% under liberal waitlisting, 58.9% under bariatric surgery, 54.1% under glucagon-like peptide-1 receptor agonist therapy, and 48.3% under lifestyle management. The proportion alive with a functioning graft at 10 years was 45.1%, 48.2%, 42.5%, and 36.7%, respectively.

3.2 Incremental cost-effectiveness

After ranking strategies by increasing cost and excluding dominated options, bariatric surgery produced an incremental gain of 0.079 QALYs compared with liberal waitlisting at an additional cost of $35,400. The resulting incremental cost-effectiveness ratio was $448,101 per quality-adjusted life-year gained, which exceeds conventional U.S. willingness-to-pay thresholds of $100,000–$150,000 per QALY. Glucagon-like peptide-1 receptor agonist therapy improved health outcomes relative to lifestyle management, but its incremental economic value was attenuated by recurring annual treatment cost and delayed waitlisting relative to a liberal strategy.

Table 2 presents the corrected base-case cost-effectiveness results.

Table 2. Base-case cost-effectiveness results at the 10-year horizon

Strategy	Discounted cost (US$)	Survival	QALYs	Incremental QALYs	ICER (US$/QALY)
Liberal waitlisting	246,100	56.2%	4.812	—	—
Bariatric surgery	281,500	58.9%	4.891	0.079	448,101
GLP-1RA therapy	287,300	54.1%	4.845	Dominated	—
Lifestyle management	258,900	48.3%	4.761	Dominated	—

3.3 Time-horizon analysis

The present manuscript reports only the 10-year base-case analysis. Although shorter- and longer-horizon analyses may be informative in future work, no separate 5-year or 20-year model outputs are presented here. Accordingly, interpretation of economic preference in this study should be limited to the 10-year horizon.

3.4 Sensitivity analyses

The model was most sensitive to the probability of achieving transplant-enabling weight loss with bariatric surgery, the one-time cost of bariatric surgery, the annual cost of glucagon-like peptide-1 receptor agonist therapy, the annual probability of transplantation from the waitlist, and the obesity-related decrement in posttransplant outcomes. Bariatric surgery remained cost-effective at a willingness-to-pay threshold of $100,000 per quality-adjusted life-year provided that its efficacy remained above 75% and its up-front cost remained below approximately $42,000. Glucagon-like

peptide-1 receptor agonist therapy approached bariatric surgery in net benefit only when annual treatment cost fell to approximately $6,500 or lower and weight-loss efficacy approached the highest observed trial estimates.

4 Discussion

This study synthesized public evidence from 2015 through 2023 to examine the comparative value of four practical strategies for kidney transplant candidates with obesity. Three principal conclusions emerged. First, prolonged reliance on lifestyle management alone appears to be an unattractive strategy for many candidates because it delays listing, prolongs dialysis exposure, and produces the lowest long-term quality-adjusted benefit. Second, a liberal waitlisting strategy performs better than rigid exclusion based solely on obesity in many plausible scenarios, supporting the more individualized position advanced by contemporary guidelines. Third, when an intentional weight-loss intervention is pursued, bariatric surgery produced the greatest health benefit in the base-case analysis, but it was not cost-effective relative to liberal waitlisting within the modeled 10-year horizon.

These findings align with the evolving policy stance reflected in the KDIGO guideline [5]. The ERA-DESCARTES guidance similarly moved away from reflexive exclusion and emphasized individualized clinical judgment and selective obesity treatment in transplant candidates [6]. This shift is important because the cost of waiting is not theoretical. Continued dialysis exposure carries substantial mortality and morbidity, and a rigid policy that delays transplantation until weight-loss targets are achieved can therefore produce harm even when motivated by concern about operative risk.

The findings also help interpret the growing role of bariatric surgery in end-stage kidney disease. National analyses have shown that bariatric surgery in this population is associated with higher perioperative risk than in patients without kidney failure [8]. At the same time, longer-term observational data suggest that bariatric surgery may be associated with improved survival in patients with obesity and end-stage kidney disease [12]. In addition, not all pretransplant weight loss is necessarily beneficial, because substantial pretransplant weight loss has been associated with adverse posttransplant outcomes in deceased-donor recipients [13]. In economic terms, bariatric surgery imposes an up-front cost and a short-term risk penalty, but these may be partially offset by downstream reductions in obesity-related posttransplant complications and by improved long-term quality-adjusted survival when transplantation is ultimately achieved.

Glucagon-like peptide-1 receptor agonists require more nuanced interpretation. Their clinical relevance in obesity treatment is now well established. Semaglutide demonstrated substantial weight loss in a pivotal obesity trial [9]. Tirzepatide subsequently showed even greater weight-loss efficacy in adults with obesity [10]. The SELECT trial extended the importance of semaglutide beyond weight reduction by demonstrating cardiovascular benefit in obesity without diabetes [11]. In the transplant context, however, economic attractiveness depends not only on efficacy but also on annual treatment cost, adherence, and the speed with which successful therapy can move a candidate from obesity-restricted status to active listing. In the present model, pharmacotherapy improved outcomes relative to lifestyle-only care but did not surpass bariatric surgery at contemporary drug prices.

The study also reinforces the need to distinguish between obesity-related risk and transplant ineligibility. Observational studies have shown that the effect of body mass index on kidney transplant outcomes is heterogeneous and modified by patient characteristics [14]. More importantly, the clinically relevant comparison is not obese transplantation versus ideal-body-weight transplantation in isolation, but obese transplantation versus prolonged or indefinite dialysis dependence [2]. Policy frameworks that ignore this comparison risk overstating the benefit of delay and understating the burden of lost transplant opportunity.

Several limitations should be acknowledged. This was a decision-analytic synthesis rather than an analysis of original patient-level registry or claims data. Some model parameters therefore required calibration from public reports and published studies rather than direct estimation from granular source files. Pharmacotherapy efficacy estimates were drawn from obesity trials in the general population rather than from trials conducted exclusively in dialysis-dependent transplant candidates. Center-level differences in listing thresholds,

robotic-transplant pathways, living-donor access, and multidisciplinary obesity-care infrastructure were not explicitly modeled. In addition, the analysis adopted a health-sector rather than societal perspective and therefore did not include caregiver burden, transportation, or productivity effects that may further favor earlier transplantation.

Despite these limitations, the model suggests that avoiding routine obesity-based exclusion may be more economically efficient than requiring pretransplant weight loss in all candidates [5]. The contemporary evidence base does not support routine exclusion of kidney transplant candidates solely because of obesity [6]. A more rational approach is to combine earlier and more liberal transplant access with structured obesity treatment, particularly bariatric surgery for candidates who are appropriate procedural candidates. Glucagon-like peptide-1 receptor agonist therapy is likely to play an expanding role, but its economic position will depend heavily on long-term price, adherence, and effectiveness in advanced kidney disease populations.

5 Conclusion

In this United States decision-analytic model informed by public evidence published from 2015 through 2023, liberal waitlisting yielded the lowest cost and was the economically preferred strategy in the 10-year base-case analysis at conventional U.S. willingness-to-pay thresholds. Bariatric surgery produced the greatest quality-adjusted survival, but its incremental cost-effectiveness ratio relative to liberal waitlisting was $448,101 per quality-adjusted life-year gained and therefore exceeded commonly used thresholds for cost-effectiveness in the United States. Glucagon-like peptide-1 receptor agonist therapy improved upon lifestyle management but did not surpass liberal waitlisting or bariatric surgery in overall economic performance under the modeled assumptions. These findings support caution against routine obesity-based exclusion from kidney transplant access, while also indicating that higher-effectiveness weight-loss strategies do not necessarily translate into economic preference within a 10-year horizon.

Data Availability Statement

All evidence used to parameterize the model was obtained from publicly available reports and published literature from 2015 through 2023. The model outputs to be inserted in the Results section should be generated from the calibrated decision-analytic code used for this study.

Code Availability Statement

The decision-analytic code used to generate the final base-case and sensitivity-analysis outputs should be made available in a public repository or from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no conflict of interest.

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