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# Comparison of open live donor nephrectomy, laparoscopic live donor nephrectomy, and hand-assisted live donor nephrectomy: A cost-minimization analysis[1]

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ABSTRACT

*Background:* Live donor kidney transplantation is the treatment of choice for end-stage renal disease. Open donor nephrectomy (ODN) was the standard until the introduction of the laparoscopic donor nephrectomy (LDN) in 1995. Hand-assisted laparoscopic donor nephrectomy (HALDN) was added shortly thereafter. The laparoscopic techniques are associated with increased operating room times and equipment costs; however, these techniques speed patient return to normal activity. The aim of this study is to evaluate the cost of these techniques.

*Materials and Methods:* A decision analysis model was developed to simulate outcomes for donors undergoing ODN, LDN, and HALDN. Outcomes were simulated from both the institutional perspective (IP) and the societal perspective (SP). Baseline values and ranges were determined from a systematic review of the literature. Sensitivity analyses were conducted to test model strength.

*Results:* From the IP, ODN is the least costly strategy with a cost of $11,000, while the cost is $15,200 for HALDN and $15,800 for LDN. From the SP, HALDN is the least costly strategy costing $27,800, while the cost for LDN is $29,000 and for ODN is $41,000. In sensitivity analysis, ODN only became the dominant strategy if the days till return to work exceeded 58 in the HALDN strategy. LDN and HALDN were nearly equivalent as the rate of open conversion of LDN approached zero.

*Conclusions:* HALDN is the least costly donor nephrectomy strategy, especially from the SP. The primary determinants of cost in this model are conversion to open and days till return to work.



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## 1. Introduction

The treatment of choice for end-stage renal disease is kidney transplantation; however, the number of potential recipients far exceeds the number of available donor organs [1]. Living donation is the only means of reliably increasing the donor supply and closing the gap between recipients and available organs. Additionally, kidney transplantation from a live donor provides superior graft survival and outcomes compared with cadaveric donors [2].

For several decades, open donor nephrectomy (ODN) was the only procedure available to those who wished to donate. Most donors are young, healthy adults, and this approach was unattractive because it entailed a painful flank incision often hindering their return to normal activity or work. In 1995, Ratner and colleagues introduced the laparoscopic donor nephrectomy (LDN) [3]. This technique yields less pain, shorter convalescence, and superior quality of life [4–8]. In an effort to improve on LDN, hand-assisted laparoscopic donor nephrectomy (HALDN) was introduced and provided better vascular control and ease of retrieval of the kidney. With the introduction of these minimally invasive techniques, the number of live donor candidates increased greatly [9].

The objective of this study was to evaluate the cost-effectiveness of ODN, LDN, and HALDN from the institutional perspective (IP) and the societal perspective (SP) using a decision analysis model. By modeling the outcomes of these three procedures, we can better understand the determinants of the cost-effectiveness of donor nephrectomy.

## 2. Materials and methods

### 2.1. The model

This study was conducted using a decision analysis design. Decision analysis is a quantitative technique for synthesizing data from numerous sources to evaluate therapeutic alternatives [10]. All decision analyses involve the following components: (1) the competing strategies and outcomes associated with each strategy are specified in a decision model, (2) the probabilities for each of these outcomes are estimated from the most appropriate available data and assigned to each decision point in the model, and (3) an analysis is performed to calculate the expected value of each treatment strategy. The expected value of each treatment alternative is then calculated and a favored strategy can be identified. All analyses were performed with TreeAge Healthcare 2009, a software used to create and evaluate decision trees and models (TreeAge Software, Williamstown, MA). TreeAge Healthcare is specifically designed for modeling decision analysis trees and allows testing of models over a wide range of clinically relevant data. The decision tree used in this analysis is illustrated in Fig. 1.

In this study, the outcome of each strategy was examined in terms of cost. This model looks at the financial impact of the three different operative approaches from both the institutional and societal perspectives. The cost from the IP includes only the direct costs of the procedure borne by the hospital. The direct costs include only costs associated with the procedure and the hospitalization. The SP includes both the direct costs of the procedure to the institution as well as the non-institutional or indirect costs borne by the patient or society. The indirect costs include economic costs associated with lost productivity and wages in the donor.

### 2.2. Assumptions

Several assumptions were made in designing the decision tree in order to simplify the analysis. The base case patient was a 35 y-old female who worked outside of the home, which described the typical patient considering kidney donation [11]. All modeled outcomes occurred in the first 6 mo after the procedure. Within each arm of the model, the donor was subject to one of the following scenarios based on predetermined probabilities: (1) uneventful recovery, (2) perioperative complications (ileus, pneumonia, wound infection, DVT, blood transfusion), or (3) perioperative complications requiring reoperation (bleeding, bowel obstruction, hernia). For each model in which the donor was undergoing HALDN or LDN, the probability of conversion to ODN was taken into account. Operative times for the procedures were considered to be equal and therefore not included in the model.

### 2.3. Probabilities

Table 1 summarizes the probabilities and estimates of the ranges of outcomes and complications used in our decision analysis model. These values are based on a critical review of the available literature regarding live donor nephrectomy. Medline was systematically searched for all articles dating from 1995 to present comparing HALDN, LDN, and ODN, especially randomized controlled trials and meta-analyses. Through this literature survey, a baseline value and a range for all variables of interest was obtained.

### 2.4. Cost data

The costs used in this analysis are also listed in Table 1. Cost data were abstracted from both published studies of institutional costs and studies in which the Medicare database was used for cost analysis. Direct hospital costs included physician services, room and board, supplies, operating room expenses, and inpatient medications. Operative times were standardized for all procedures but operating room costs were adjusted based on the use of open or laparoscopic instrumentation. Indirect costs were those associated with lost productivity during the hospitalization and subsequent recuperative period. Using standard methods, indirect costs were valued based on gender- and age-specific average hourly wage rates from the Bureau of Labor Statistics Current Population Survey. Costs associated with complications of interest were approximated using Medicare costs for the treatment of these complications supplied by the University Hospital Consortium (UHC) Clinical Information Network.

### 2.5. Sensitivity analysis

Sensitivity analyses were used to assess the stability of the results obtained from the model for probabilities, costs, and