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Lung transplantation in the spotlight: Reasons for high-cost procedures

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BACKGROUND: Hospital treatment costs of lung transplantation are insufficiently analyzed. Accordingly, it remains unknown, whether current Diagnosis Related Groups, merely accounting for 3 ventilation time intervals and length of hospital stay, reproduce costs properly, even when an increasing number of complex recipients are treated. Therefore, in this cost determination study, actual costs were calculated and cost drivers identified.

METHODS: A standardized microcosting approach allowed for individual cost calculations in 780 lung transplant patients taken care of at Hannover Medical School and University of Munich from 2009 to 2013. A generalized linear model facilitated the determination of characteristics predictive for inpatient costs.

RESULTS: Lung transplantation costs varied substantially by major diagnosis, with a mean of €85,946 (median €52,938 ± 3,081). Length of stay and ventilation time properly reproduced costs in many cases. However, complications requiring prolonged ventilation or reinterventions were identified as additional significant cost drivers, responsible for high costs.

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CONCLUSIONS: Diagnosis Related Groups properly reproduce actual lung transplantation costs in straightforward cases, but costs in complex cases may remain underestimated. Improved grouping should consider major diagnosis, a higher gradation of ventilation time, and the number of reinterventions to allow for more reasonable reimbursement.
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Lung transplantation (LTX) represents the therapy of choice for a growing number of patients with end-stage lung diseases.[1] In selected patients, LTX significantly prolongs survival and improves quality of life.[2–5] Along with the rapid increase of the LTX rate, the proportion of complex recipients has also continuously risen, thereby presumably augmenting inpatient treatment expenses.[1,6,7]

A case in point is that even critically ill patients, supported by invasive ventilation and/or extracorporeal membrane oxygenation therapy as a bridge to transplant, may be listed.[8] However, expansion of the LTX indications toward more complex recipients is paralleled by a higher rate of difficult postoperative courses of treatment. Unexpected complications after LTx may afford a multitude of additional diagnostic and therapeutic measures, raising expenses disproportionally. Furthermore, to ameliorate donor organ shortage, an increasing number of extended-criteria donor lungs are accepted. These may complicate the post-operative course additionally. Hence, LTX patient care today represents an increasing financial challenge, even for highly specialized centers.[9]

Prospective payment schemes, such as the Diagnosis Related Groups (DRG) system, ideally generate medically and economically homogenous groups for reimbursement calculations. However, for LTX in Germany only 3 DRGs, accounting for different ventilation time (VT) intervals, may be applied (A03A $\leq$ 179 hours, A03B $>$ 179 hours, and A18Z $>$ 999 hours)[9] and only 1 DRG exists in the United States (U.S.) and the United Kingdom.[10,11] Hence, the current DRG breakdown may be too coarse, thus potentially disregarding the growing heterogeneity and increasing comorbidity within the LTX patient cohort.

Furthermore, because certain risk factors, indicative for a complicated LTX course are readily identifiable preoperatively, a preference of "low-risk" patients may be imminent. Although a conservative patient selection might even help to augment the overall cost effectiveness of LTX, an increasingly economically driven selection carries a risk. To guarantee a reasonable reimbursement and to avoid an unintentional selection, it is indispensable to be aware of actual cost structures and to account for cost-relevant prognostic factors. Therefore, the aim of this cost-determination study was to analyze LTX inpatient costs from a hospital's perspective and identify cost-relevant patient and care characteristics.

In detail, we applied the Institute for the Hospital Remuneration System (InEK) calculation scheme to analyze LTX costs.[12,13] InEK is currently used by approximately 250 German hospitals to calculate DRG standard rates for reimbursement and represents a generally accepted, transparent costing standard that uses an activity-based microcosting approach. The InEK scheme differentiates by cost centers and cost categories. Each combination of cost center and cost category is allocated to an activity-based cost driver, and costs are directly assigned to individual patients.

Methods

The Hannover Medical School (MHH) Ethics Committee and the Ludwig-Maximilians University (LMU) Ethics Committee granted ethics approval for this study.

Study population

Data were acquired at the 2 largest German LTX centers, MHH, covering the northwestern part of Germany, and the University of Munich (LMU), covering the southern area of Germany. Patients who received a transplant at those 2 centers from January 2009 to December 2013 were evaluated, representing 47.6% of the nationwide LTX volume.[7] Of 780 patients in total, 572 (73%) were treated at the MHH and 208 (27%) at the LMU.[7] In that period, the LTX rate increased by 71% at the MHH and by 43% at LMU. LMU data from 2011 had to be omitted because InEK data were not available.

Study design

LTX costs were analyzed in a 5-year, cross-sectional approach. Clinical and sociodemographic data were gathered from hospital medical records. Inpatient costs and data of resource utilization, such as service/activity statistics, were collected on the patient level from the hospitals' cost-accounting systems. Total costs comprised direct costs, including labor (physicians, nursing, and technical staff), drugs, and materials (expendables), and indirect costs (infrastructural costs: technical and management). Within the data set, we determined cost-center and cost-category groups. Each combination of cost center and cost category was allocated to an activity-based cost driver. Hence, LTX costs were directly allocated to individual patients (activity-based microcosting[14,15]). Calculation of mean costs for each cost category/cost center of the cost matrix facilitated the identification of expenses responsible for cost differences of LTX indications. Cost calculations were based on the consumer price index of the federal statistical office and were adjusted for inflation up until 2013.[16] Notably, cost-determination analyses focus on costs and cost structures and should be differentiated from cost-effectiveness studies, where outcomes are frequently incorporated into a cost-effectiveness ratio, typically expressed in quality-adjusted life-years.

Statistical analysis

Descriptive statistics have been calculated, including the mean, median, and standard error of the mean. Because ordinary least-squares (OLS) regression models require Gaussian distribution,