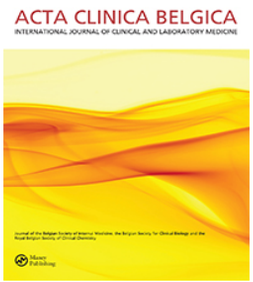
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Cost of 1-year left ventricular assist device destination therapy in chronic heart failure: a comparison with heart transplantation

W. Droogne[1], S. Jacobs[2], K. Van den Bossche[2], J. Verhoeven[2], R. R. Bostic[3], J. Vanhaecke[1], J. Van Cleemput[1], F. Rega[2], B. Meyns[2]

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Objective: To analyse overall cost involved with destination therapy (DT) in comparison to transplantation (HTX) and bridging to transplantation.
Methods: Three groups of patients at one hospital were considered for this cost analysis: (1) patients included in the BENEMACS study starting May 2009 (n=6); (2) all patients from May 2009 till May 2010 undergoing heart transplantation (n=19); or (iii) undergoing Heartmate II implantation as a bridge to transplant (n=13). Patients undergoing bridging were more sick (lower Intermacs class). DT patients were older (64±8 years). Cost was derived from actual hospital invoices, device, organ procurement and medical cost, and follow-up care during 1 year from implantation. Costs are presented in euro, by their mean values and standard deviation.
Results: One-year survivals were 83, 84, and 77%, respectively, for DT, HTX, and bridging. Costs for initial and re-hospitalizations were not different between groups. Costs for medical follow-up and medication were significantly higher for transplanted patients. The 1-year total cost was €85 531±19 823 for HTX, €125 108±32 399 for bridging, and €137 068±29 007 for DT. As 42% of the transplanted patients were bridged, the cost of the medical pathway HTX was €138 076±19 823. Assuming a 5-year survival and a similar yearly follow-up cost, the average cost per year is €42 153 for HTX, €53 637 for transplantation including the bridging cost, and €47 487 for DT.
Conclusion: Direct transplantation without bridging is the most cost-efficient treatment. The cost per patient per year for DT is similar to HTX considering its bridging activity.

Keywords: Destination therapy, Cost, VAD, Heart transplantation

Introduction

Chronic heart failure is prevalent, leads to significant loss in quality of life and has a high morbidity and mortality.[1–3] In a nationwide survey, the incidence of heart failure in Belgium was estimated to be 194 per 100 000 adult inhabitants per year. This translated to 15 643 newly diagnosed adult patients each year, with the majority (50%) being in NYHA III at time of diagnosis and a 1-year mortality rate of 26%.[4]

Given the increasing age of people in the Western world, it is expected that the prevalence will not diminish and that the effect on society will increase. Left ventricular assist devices (LVADs) are currently accepted therapy for patients waiting heart transplantation. Current medical practice has shifted the indication towards implantation of these devices for borderline indications for transplantation and even more frequently as an alternative to transplantation; known as destination therapy.[5] In addition, smaller assist devices are now available to use as a treatment for symptomatic chronic heart failure in patients, not eligible for heart transplantation.[6]

The BENEMACS destination therapy study was conducted to demonstrate the feasibility of destination therapy for chronic heart failure in Belgium and the Netherlands with the Heartmate II (Thoratec Inc., Pleasanton, CA, USA) assist device. We then sought to analyse whether the cost of this treatment is acceptable in Belgium.

Methods

Patients

Three groups of patients were considered for this cost analysis: (i) patients included in the BENEMACS destination therapy study starting May 2009; (ii) all patients undergoing heart transplantation from May

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Table 1 Patient demographics

	Heart transplantation (n=19)	Bridge to transplant (n=13)	Destination (n=6)
Age (mean±SD)	53±11	46±15	64±8
Gender (M/F)	15/4	12/1	6/0
Diagnosis (dilated/ischemic/other in %)	11/79/11	15/62/23	83/17/0
Intermacs class (I/II-III/≥IV in %)	0/0/100	62/31/8	33/33/33
Initial hospital days (mean±SD)	30.3±16.2	41.1±28.1	43.2±34.3

2009 till May 2010; and (iii) all patients undergoing Heartmate II implantation as bridge to transplant in that same period.

Patient demographics are illustrated in Table 1. In our institution, six patients were included in the BENEMACS trial, while 19 were transplanted and 13 had a Heartmate II implanted as bridge to transplantation.

Patients included in the destination therapy trial were significantly older as age was the most frequent cause of exclusion for transplantation. Patients who received the Heartmate II as bridge to transplantation were younger and sicker as indicated by their lower Intermacs class.

Cost calculation

Hospital invoices of patients were retrieved for a 1-year period starting from the first day of the treatment (transplantation or VAD implantation). This cost includes payments for medical and paramedical personnel, diagnostic investigations, in-hospital medication, medical materials and the indirect cost as calculated by the cost of in-hospital days.

The hospital invoices were split by time blocks to create three cumulated cost calculations: (i) the cost of the implantation procedure and hospitalization; (ii) the combined cost of re-hospitalizations for other reasons; and (iii) the combined cost of follow-up investigations throughout 1 year. As all patients were followed uniquely by our institution, we consider these hospital cost as complete.

The cost of the device (Heartmate II) is determined by local reimbursement regulations and is fixed at €69 239.1. The cost of a donor organ is difficult to calculate. Medical fees and transportation fees are included in the hospital invoices of the transplantation procedure itself. However, the indirect cost, provided by society, to allow organ transplantation, is hard to grasp. The indirect cost of the transplant activity was estimated by considering the total expenditure of our transplant coordinators and dividing this by the number of transplants done in a given year.

Besides hospital cost, the ambulatory medication cost was calculated for a 1-year period. To do so, the scheme of medical prescriptions was retrieved per patient and the total price of the medication was calculated, regardless of the form of payment or reimbursement.

Routine follow-up

The cost of follow-up care depends strongly on the applied model of routine follow-up. Routinely, patients with a VAD (bridge or destination) were seen every week after discharge for the first month, and every 2 months afterwards. At these visits, a clinical examination and blood analysis were done. Every 4 months and in the case of medical need, these follow-ups are extended with echocardiography and exercise testing.

Patients undergoing heart transplantation are seen the first year for 16 biopsies with transthoracic echocardiography, ECG, chest X-ray, and blood analysis.

Data

Costs are presented in euro, by their mean values, standard deviation, and range. Comparisons of continuous data were done with the unpaired Student's t-test. A P-value lower than 0.05 was considered significant.

Results

Patient outcome

Of the six patients receiving an LVAD for destination therapy, one patient died after 109 days (83% 1-year survival). He was never able to be rehabilitated or discharged from the hospital and died finally in multiple organ failure.

Sixteen of the 19 patients undergoing transplantation survived (84% 1-year survival). Of the 13 patients undergoing Heartmate II implantation as bridge to transplantation, three died and six were transplanted during their first year (77% 1-year survival).

Adverse events, necessitating hospital visits or admissions besides the planned routine, were most frequently due to driveline infections (21%) and bleeding complications (11%) for patients living with a VAD. Patients living with a transplant heart experienced more adverse events due to complications related to the immunosuppressive medication (26%).

Medical cost

Medical costs are summarized in Table 2. The expense of the initial hospitalization shows a large range between minimal and maximal values (€20 000–146 000) in the three treatment groups. Overall, device implantation seems to be less expensive than transplantation. As the surgical procedure is similar and the length of stay does not differ, most of

Table 2 Cost for transplantation, bridge to transplantation and destination therapy (in euro by mean value±standard deviation and range)

	Transplantation (n=19)	Bridge to HTX (n=13)	Destination (n=6)
Initial hospitalization	56 778±20 833	47 526±32 612	45 453±28 577
Range	19 854–97 570	19 800–146 122	22 281–98 331
Cost for re-hospitalization/month	364±509	739±1897	2200±3272
Range	0–1646	0–6845	0–7815
Follow-up cost/month	1759±299	426±242	343±111
Range	1263–2326	190–1025	204–493
Medication cost/month	486±271	55±48	78±19
Range	206–1369	10–130	48–100
Total 1-year medical cost	83 966±19 823	55 869±32 399	67 829±29 007
Range	45 280–115 197	16 695–146 122	25 687–99 861
Total 1-year cost (including device and indirect HTX cost)	85 531±19 823	125 108±32 399	137 068±29 007

the extra cost related to transplantation is due to additional medication and attributed fees for donor procurement and transportation involved.

The average monthly cost for re-hospitalization seems higher for the destination therapy patients. However, the variability is high and the differences are not significant.

The average monthly cost for follow-up investigations is significantly higher for transplant patients ($P<0.01$). Similarly, the monthly expense for medication is significantly lower for VAD patients (no need for immune suppressive drugs) ($P<0.01$).

It adds up to a higher medical cost for 1-year transplantation care as compared to VAD care. The difference in cost between bridge patients and destination therapy is not significant ($P=0.4$).

Figure 1 depicts the average cumulative cost for the three treatment groups.

Cost including device and donor organ.

The indirect cost of the donor organ was calculated to be €1565.3 (fees of transplant coordinators per transplanted organ). The total LVAD cost (Heartmate II) comes to €69 239.1. Clearly, all patients receiving a VAD as bridge to transplantation will finally consume the cost of a heart transplantation as well. During the 1-year follow-up period in this study, six patients in that group were indeed transplanted.

Heart transplantation without the use of a VAD is the most cost-efficient solution. However, heart transplantation as a medical pathway includes the possibility that some patients need to be bridged

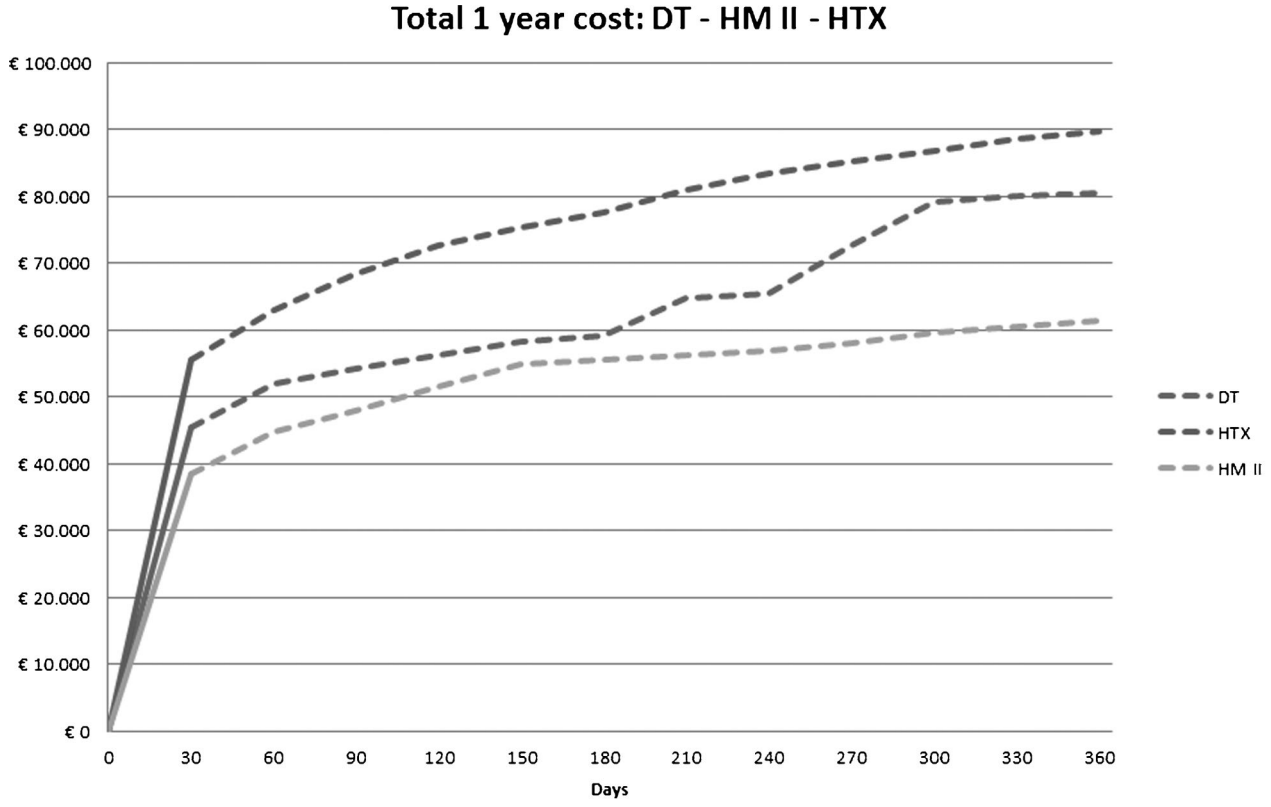


Figure 1 Total 1-year medical cost for the three treatment groups (transplantation, bridging, and destination). The solid lines indicate the cost of the initial hospitalization. The dotted lines indicate the summation of cost by re-admissions, routine follow-up, and medication.

during their waiting time. The percentage of transplanted patients who needed to be bridged in our observation period was 42%. The cost per life year was therefore calculated by adding 42% of the life year bridge cost to the life year cost for transplantation. This assumption ends up with a total 1 year cost of €138 076 for the patient group following the medical pathway transplantation (cost of transplantation including its potential bridging cost).

Projected life year cost for the following years

In transplantation and device implantation, the major part of the medical and device costs are made in the first year, so the cost per year diminishes when the patient lives longer. In order to understand how costs will behave in time, we projected cost per year over 5 years assuming that (1) the cost for re-hospitalization, medication, and follow-up would remain the same; (2) that all patients stay alive; and (3) that prices for devices and services remain unaltered. Since 2010, the cost for personnel equipment like batteries and chargers is as well reimbursed by the local government. This cost (€968 per month during first year and €484 during the following years) is added to the device cost for destination therapy in this projection. Doing so, the cost per year is assumed to be an average of €42 153 for transplantation, €53 637 for transplantation including the bridge cost and €47 487 for destination therapy for patients living 5 years (Fig. 2).

Cost per lived year

Mortality plays an important role in the total cost per year. Similarly, the transplantation rate in the bridge group influences the total cost per year of bridging. To assess the effect of drop-outs, we calculated cost per actual lived year for the three groups. Cost per lived year is obtained by dividing the total cost of the group by the observed lived days. Total cost per lived year in the first year is €100 332 for transplantation, €203 370 for bridging, and €156 100 for destination therapy. Considering the percentage of bridged patients (42%), the total average cost per lived first year was €185 747 for transplantation and €156 100 for destination therapy.

Discussion

Growing experience and incremental improvements in VAD technology have led to improved medical outcomes. As a consequence, several studies showed that the reduced adverse event rate results in reduced medical cost.[7–9] It remains, however, challenging to determine if society can afford to provide LVAD therapy for all patients who could medically benefit from it. Moreno *et al.* analysed with a probabilistic Markov model the use of resources of a hypothetic cohort of patients undergoing either transplantation or LVAD therapy as bridge to transplantation.[10] They concluded that bridging with LVADs save lives, but do not provide good value for the money considering the high acquisition cost of the device.

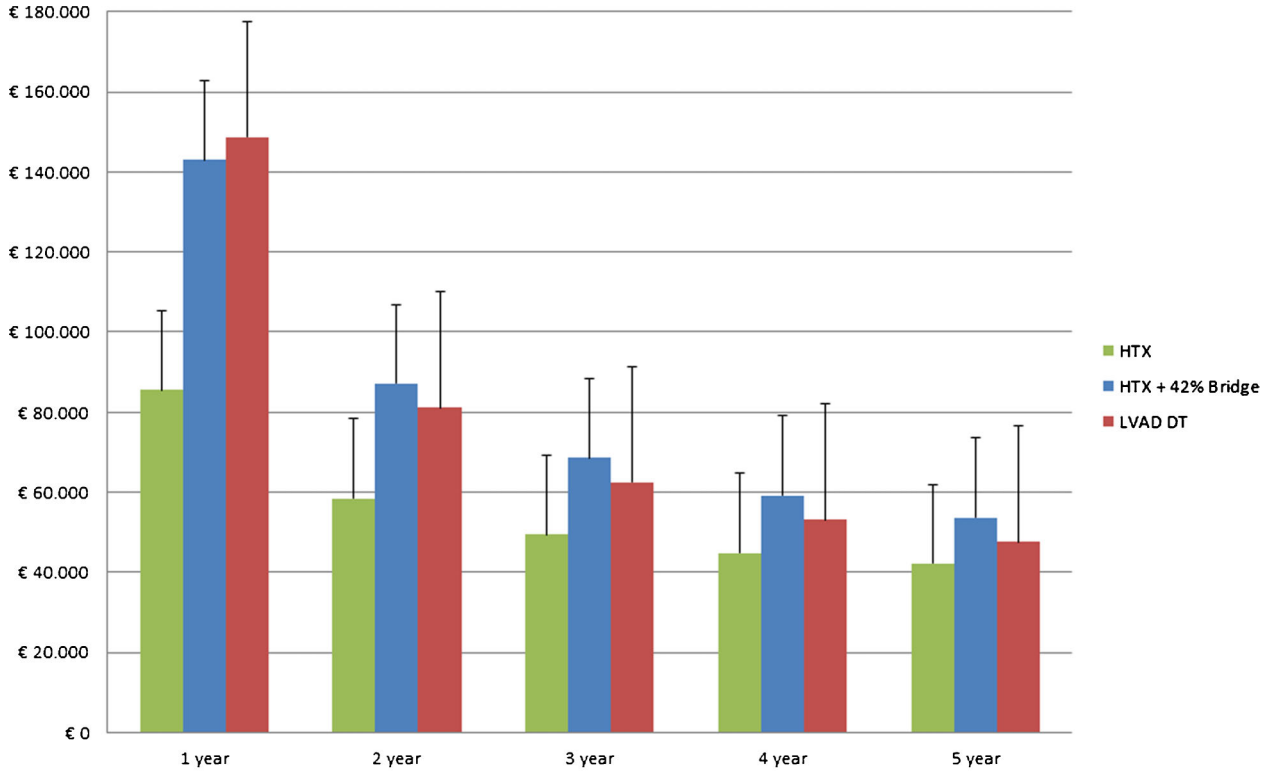


Figure 2 Estimated cost per year for the three treatment modalities (transplantation, transplantation including bridging, and destination therapy). The cost per year diminishes when the patient lives longer.

A major limitation of such an analysis is the ever changing cost estimates of VAD therapy as it is still an evolving field. Secondly, as pointed out by Slaughter and Rogers, the cost of the hypothetical control group is underestimated as in reality several of these patients are switched over to receive a VAD in order to save their life.[11]

In an attempt to add experience to this domain, we recorded cost, based on actual hospital invoices and other medical cost, during a complete year in three competing groups: transplantation, bridge to transplantation and destination therapy. Clearly, a similar limitation occurs as these three groups are not really competing. For one, patients received the therapy according to their medical condition and prognosis. Patients undergoing destination therapy were older; patients undergoing bridging to transplantation were more sick (lower Intermacs class). Secondly, patients undergoing LVAD therapy for bridging are determined to get as well the cost of the transplantation and *vice versa*, some patients undergoing transplantation had already consumed the bridging cost (in our series, 42%).

A direct comparison of costs in these treatment modalities will always be limited by the treatment bias and is not the real goal of this cost analysis. The comparison is merely made to create a reference for the societal burden of LVAD destination therapy. In our series, the medical cost seems to be comparable with heart transplantation. The overall cost of destination therapy seems to be less than the current costs involved with heart transplantation and its bridging activity.

The cost of the device itself is a major contributor to the overall cost perspective in LVAD therapy and with increasing medical outcomes, its relative importance increases. Since the end of this study, the reimbursement for VAD therapy in Belgium includes an additional monthly fee of €968 to cover for supporting materials like batteries, chargers, and other personnel equipment, increasing the total device cost for 1-year VAD therapy to €80 855.1. This device cost exceeds the actual medical cost provided. The cost per year for destination therapy turned out to be an average of €47 487 in our series for patients living 5 years. This estimation of future cost bears several limitations. Firstly, we have assumed similar follow-up costs, while for patients after heart transplantation, the need for follow-up biopsies decreases after the first year. Secondly, we assumed in contrast to reality, that prices of devices and services remain unaltered. Thirdly, mortality plays an important role in the overall amount of money spent. According to the latest Intermacs report, the 5-year survival rate for patients receiving a rotary VAD for destination therapy is 60%,[5] whereas the 5-year survival after transplantation is 68%. When patients die, the overall cost for the population is less than projected.

We did not analyse quality of life in the three studied groups, because of the retrospective nature of the study. Prospective quality of life assessment is important in delineating the role of destination therapy in chronic heart failure. At the moment, along with other authors, Kugler and colleagues indicated that quality of life improves more significantly after transplantation as compared with VAD patients, especially in their exercise tolerance.[12] Transplantation has the obvious advantage that the patient is not plagued with a percutaneous drive line and constant battery care and is therefore the preferred therapy, regardless of cost. Destination therapy is aimed for patients who are not transplantable and are eligible for this therapy.

Limitations

This retrospective study is limited by the bias of treatment in the patients studied. Assuming medical cost based on hospital invoices has multiple limitations. For one, hospitals can work with profit or loss. The invoice depends heavily on the local reimbursement situation in each country. Thirdly, hospital invoices tend to underestimate several aspects of indirect cost provided by society. In order to compensate for this deficiency, we compared the cost calculation of destination therapy to bridging and transplantation in the same time frame and at the same hospital. In addition, the invoice does reflect what the payer finally has to pay.

Conflicts of Interest

Robin Bostic is employed by Thoratec Inc. Bart Meyns is principal investigator of the BENEMACS trial.

Acknowledgements

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References

1 Bui AL, Horwich TB, Fonarow GC. Epidemiology and risk profile of heart failure. Nat Rev Cardiol 2011;8:30–41.
2 Bleumink GS, Knetsch AM, Sturkenboom MC, Straus SM, Hofman A, Deckers JW, *et al.* Quantifying the heart failure epidemic: prevalence, incidence rate, lifetime risk and prognosis of heart failure: the Rotterdam Study. Eur Heart J 2004;25:1614–9.
3 Levy D, Kenchaiah S, Larson MG, Benjamin EJ, Kupka MJ, Ho KK, *et al.* Long-term trends in the incidence of and survival with heart failure. N Engl J Med. 2002;347:1397–402.
4 Devroey D, van Casteren V. The incidence and first-year mortality of heart failure in Belgium: a 2-year nationwide prospective registration. Int J Clin Pract. 2010;64:330–5.
5 Kirklin JK, Naftel DC, Kormos RL, Stevenson LW, Pagani FD, Miller MA, *et al.* The Fourth INTERMACS Annual Report: 4,000 implants and counting. J Heart Lung Transplant. 2012;31:117–26.
6 Meyns BP, Simon A, Klotz S, Wittwer T, Schlensak C, Rega F, *et al.* Clinical benefits of partial circulatory support in New

York Heart Association Class IIIB and Early Class IV patients. Eur J Cardiothorac Surg. 201;39:693–8.
7 Slaughter MS, Bostic R, Tong K, Russo M, Rogers JG. Temporal changes in hospital costs for left ventricular assist device implantation. J Card Surg. 2011;26:535–41.
8 Rogers JG, Bostic RR, Tong KB, Adamson R, Russo M, Slaughter MS. Cost-effectiveness analysis of continuous-flow destination therapy. Circ Heart Fail. 2012;5:10–6.
9 Mishra V, Fiane AE, Geiran O, Sorensen G, Khushi I, Hagen TP. Hospital costs fell as numbers of LVADs were increasing: experiences from Oslo university hospital. J Cardiothorac Surg. 2012;7:76.
10 Moreno SG, Novielli N, Cooper NJ. Cost-effectiveness of the implantable Heartmate II left ventricular assist device for patients awaiting heart transplantation. J Heart Lung Transplant. 2012;31:450–8.
11 Slaughter MS, Rogers JG. Editorial Commentary: Determining the cost-effectiveness of mechanical circulatory support. J Heart Lung Transplant. 2012;31:448–9.
12 Kugler C, Malesha D, Tegtbur U, Guetzlaff E, Meyer AL, Bara C, *et al.* Health related quality of life and exercise tolerance in recipients of heart transplants and left ventricular assist devices: a prospective, comparative study. J Heart Lung Transplant. 2011;30:204–10.