Challenge of Informing Patient Decision Making
What Can We Tell Patients Considering Long-Term Mechanical Circulatory Support About Outcomes, Daily Life, and End-of-Life Issues?

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Background
In the management of advanced heart failure, the option of long-term mechanical circulatory support (MCS) as destination therapy (DT), rather than as a temporary bridge to cardiac transplantation, is increasingly being offered to highly selected patients. Recent technological advancements in implantable devices, such as continuous flow systems and smaller pump sizes, have increased the possibility of survival with fewer complications. Informed consent before MCS is essential1-6 and is a fundamental aspect of patient-centered care. As a part of a quality decision-making process, the patient considering MCS and his/her informal caregiver(s) need to be aware of the current state of the scientific evidence, including what is known and unknown about outcomes and living with MCS and must navigate a series of interactions with clinicians before deciding on the treatment course.

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The Institut National d’Excellence en Santé et en Services Sociaux is a health technology assessment and clinical guideline development organization in the province of Quebec (Canada) that provides multiple stakeholders (ie, government officials, hospital administrators, physicians, and patient organizations) with evidence-based information. In 2011, the Quebec Ministry of Health requested that the Institut National d’Excellence en Santé et en Services Sociaux provide recommendations on the use of implantable left ventricular assist devices in end-stage chronic heart failure. The current article extends the work submitted to the Ministry1 and focuses on MCS use in DT, within the framework of informed decision making.

In this perspective piece, we report on our review of the scientific literature concerning clinical outcomes in DT and on perspectives of DT patients and their caregivers, to provide a summary of currently available information and identify gaps in knowledge. Besides the use of MCS as a bridge to transplantation, we do not consider in this perspective the other clinical recourses to MCS (rescue therapy and bridge to decision) where circumstances may make the informed decision-making process particularly problematic. Our work is aimed at not only specialists in the field but also the general cardiology audience that may not be familiar with this specialized literature. Our methods included a search of the peer-reviewed scientific literature published in English or French from January 2000 to the end of December 2012, using the PubMed bibliographic database and key words and reference lists of retrieved documents. We consulted primary research articles and consensus scientific statements, expert opinion editorials, and review articles. The most recent clinical practice guidelines concerning MCS by the International Society for Heart and Lung Transplantation and the most recent annual report of the Interagency Registry for Mechanically Assisted Circulatory Support, at the time of our review, were also consulted. We extracted data on outcomes from all empirical studies of DT patients who received HeartMate II (the implantable device currently most often used for DT) and that were published since 2008 (the year in which the device was approved for DT in the United States). We also extracted data from all empirical studies that involved ≥1 DT patients (or informal caregiver of a DT patient) on living with MCS, providing care to a recipient, or terminating MCS. For studies with mixed patient populations, information specific to DT patients was extracted whenever possible. An independent committee of clinical experts (1 cardiologist [A.D.] and 3 cardiac surgeons [É.C., M.C., R.C.]), active in the MCS domain, assisted with the interpretation of results.

Framework: Informed Decision Making
Informed decision making is an ethical norm and legal mandate, which refers to the voluntary choosing of an intervention (or of no intervention) by a patient, or by his/her decision-making proxy, in light of ongoing discussion with...
that buttresses the physician–patient relationship.” The Figure summarizes the central elements of an informed decision-making process concerning MCS, grouped by topic. The process should ideally be (1) patient-centered, (2) timely, (3) comprehensive, (4) bidirectional (patient-care provider), (5) multidisciplinary, (6) ongoing, and (7) responsive to changes in situation and preferences. In addition to receiving information about the reported clinical outcomes of long-term MCS, specific to the device being offered, we think that to be fully informed, the patient should also be made aware of the limitations of current scientific evidence and be given some sense of how similar patients in the literature are to him or herself. The information should be based on the best available evidence and appropriately collected, summarized, and appraised. Importantly, this information should be made comprehensible to a lay audience.

We believe 3 important considerations pertain to the framing of the patient–clinician discussion about long-term MCS: (1) in advanced heart failure, as in other areas of medicine, there is inherent uncertainty on a patient’s specific course; (2) MCS may be the only option left to the patient to extend his/her life (although in some settings the patient considering MCS as DT may be less sick); and (3) the extent to which patients and their informal caregivers will be able to absorb information and grasp details about clinical outcomes and research findings can be highly variable given the gravity of a patient’s condition, the circumstances in which the discussions take place, and differing degrees of patient and caregiver comprehension.

**Anticipated Benefits and Risks of MCS**

From a total of 831 citations identified by our literature search, we retained 7 articles that addressed this theme, representing an evidence base of a maximum of ≥2000 DT patients. Five articles concerned clinical research studies: a multi-center randomized controlled trial, a multi-center continued protocol access case series following the trial, an analysis of data from these first 2 studies, a case series from a single center that participated in the first 2 studies, and a multi-center investigation of neurocognitive function on a subset of the trial patients. Two articles presented data from the Inter-agency Registry for Mechanically Assisted Circulatory Support in the United States from June 23, 2006, to June 30, 2012 (114 centers), and to December 31, 2011 (specific to DT). The registry did not include the patients enrolled in the trial or the continued access series.

Overall, the average age of DT patients in the literature was ≥63 years, and the majority (80%) of patients in the research studies were men. Before MCS in the research studies, most patients (66%) were in New York Heart Association class IV (heart failure symptoms were experienced even at rest), 64% were not ambulatory, and 75% were receiving intravenous inotropic therapy. Before MCS, 38% were inotrope-dependent and 75% were receiving intravenous inotropic therapy. Before MCS, 75% of registry DT patients were in 1 of the 3 most severe Interagency Registry for Mechanically Assisted Circulatory Support profile levels, indicating their hemodynamic status: 11% critical cardiogenic shock (level 1), 38% progressive decline (level 2), and 30% stable but inotrope-dependent (level 3). The research studies specify that the median duration of MCS was 1.7 to 2.1 years (minimum <1 month, maximum 6 years).

Table 1 summarizes the results with respect to clinical outcomes documented in the literature (What We Know column). We also summarize limitations and missing elements (What We Do Not Know column). In Table 1 in the Data Supplement, the number of persons with data is specified for each outcome, and details about study patients are provided.

Table 1 shows that survival, functional capacity, end-organ function, and quality-of-life results are favorable in the published literature. Based on the most recent available data, DT patients have shown a 75% chance of surviving for 1 year and a 66% chance of surviving for 2 years. The patient considering DT needs to understand that there is a certain level of uncertainty surrounding study-based estimates. For individualized assessment of expected survival whether the patient accepts or declines MCS, the clinician considers patient risk factors such as age, clinical status (including Interagency Registry for Mechanically Assisted Circulatory Support profile level, renal dysfunction, and right ventricular function), the patient’s unique psychosocial profile, medical history, medication intolerance, and the complexity of the surgical procedure(s) being considered. Risk models are used to help assess likelihood of survival, as well as the likelihood of complications during MCS for an individual patient but are likewise associated with uncertainty (a review of these is beyond the scope of this perspective). Moreover, the value...
Table 1. Clinical Outcomes for DT Patients

<table>
<thead>
<tr>
<th>What We Know</th>
<th>What We Do Not Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival*</td>
<td>No published information beyond 2 y</td>
</tr>
<tr>
<td>NYHA class</td>
<td>Limited numbers of patients with 2-y data: 100–150 persons for NYHA class, 6-minute walk distance, activity level, time spent readmitted, adverse events; &lt;50 patients for end-organ function</td>
</tr>
<tr>
<td>6-minute walk distance</td>
<td>No published information on other important end-organ function (hepatic, renal)</td>
</tr>
<tr>
<td>Activity level†</td>
<td>For functional, end-organ, and quality-of-life tests, results (and patients’ features) not known for those who could not be evaluated</td>
</tr>
<tr>
<td>Quality of life§</td>
<td>We do not know whether research study participants do better, or worse, than other DT patients</td>
</tr>
</tbody>
</table>

Initial hospitalization
After the implantation procedure, 50% of patients spent ≥23 days in hospital. A total of 87% of patients were discharged. No information about either the range in length of the initial hospitalization or the features of those who were not discharged.

Hospital readmissions during support
A total of 81% were readmitted at least once for an average of 6 days/patient per year. No information about how many patients have ≥1 readmission.

Primary causes: bleeding (30% of readmissions); cardiac-related (24%); infection (14%); thrombosis (7%); major neurological event (6%); liver-related (4%); pump alarm or abnormal readout (3%)2

No information about the outcomes for those who had repeated readmissions.

Recipient’s spent 12% of support time in hospital.
No information about the range (in days) in length of support time in hospital.

Adverse events during support
Categories are nonexclusive

<table>
<thead>
<tr>
<th>Percentage of recipients affected (most recent data19):</th>
</tr>
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<tbody>
<tr>
<td>74</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>45</td>
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<tr>
<td>33</td>
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<td>38</td>
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<td>30</td>
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<td>27</td>
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<td>20</td>
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<td>21</td>
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</tbody>
</table>

(Continued)
given to survival estimates on MCS will vary as a function of the importance each patient assigns to the possibility of living longer, and better (see below), and the price the patient is willing to pay in terms of constraints and potential complications.

Current data estimate that 80% of tested left ventricular assist device recipients had no or only slight activity limitations at 2 years after implantation (ie, New York Heart Association class I or II symptoms).9,10 The patients who were tested before implantation were in New York Heart Association class III (30% of patients) or class IV (70%).9,10 Patients who were ambulatory before receiving MCS became able to walk an average of >340 m in 6 minutes (ie, the length of 3 football fields) 2 years later.9,10 Sixty percent of recipients could perform at least moderate if not more strenuous activities at 2 years (eg, walking at a casual speed, light gardening, or housekeeping); only 4% reported such activity levels before implantation.12 Tested patients reported significantly improved quality of life at 2 years compared with before MCS.9,10 Impact on quality of life, rather than only survival, is central to the importance each patient assigns to the possibility of living longer, and better (see below), and the price the patient is willing to pay in terms of constraints and potential complications.

Table 1 shows that adverse events during left ventricular assist device support are common, and many are life-ending or life-altering (eg, stroke). Based on the most recent article that provides data in terms of the number of patients affected,10 74% of DT patients had bleeding that required a transfusion (≥2 U of red blood cells within 24 hours), 50% had an arrhythmia requiring cardioversion or defibrillation, and at least 27% developed a device-related or blood-borne infection requiring antimicrobial therapy. Although bleeding requiring surgery or transfusion was much more frequent in the first 30 days after implantation, arrhythmias and infections could occur throughout MCS (based on temporal data from bridge to transplantation MCS patients). The most frequent infections related to a device component were those involving the driveline exiting the body; most infections of this type occur after the first 30 days of support. Ischemic stroke affected 8%, hemorrhagic stroke affected 5%, and 8% had their pump replaced. In the first 6 months after implantation, readmissions for complications were most often the result of bleeding and cardiac problems (arrhythmia, heart failure, or chest pain).12

Besides the complexity of individualized risk assessment, the main limitations of the findings on clinical outcomes include the paucity of data >2 years of support. Even during the first 2 years, relatively small numbers of patients provide data for some outcomes (eg, neurocognition). These are critical points because DT is by definition intended as long-term support. The possibility that the results are biased toward patients doing better should also be considered because not everyone could be tested at all time points for all outcomes.

### Expectations for Daily Life

Patients using MCS must maintain regular contact with the MCS team, travel to medical appointments, undergo frequent clinical tests, manage equipment (eg, tend to dressings, respond to alarms, change batteries, perform system tests, and protect parts from moisture), and continue to adhere to a strict medication regimen.25,26 Adaptation of lifestyle is required,2,25,27 and availability of social support is essential.1,3,28 As another part of the informed decision-making process, therefore, the patient considering DT requires information on what to expect in daily life on MCS.4 Meeting and being able to exchange with a patient already on MCS can be most helpful.

From a total of 108 citations identified by our literature search, we retained 7 articles that examined this theme.28–34
Although multiple domains of life were addressed, this literature was limited: studies had small sample sizes (5–15 persons), all took place at single sites, and 5 studies were from the same institution in the United States. Information specific to DT patients or their informal caregivers were almost always lacking because 6 study samples also included patients who received MCS for other indications (notably MCS as a bridge to cardiac transplantation). For most of the results presented below (unless otherwise indicated), ≈20% of study participants received DT. Patients varied in age from 31 to 76 years, and caregivers were 39 to 71 years of age. Eight-five percent of patients were men; all caregivers were women. Results and their limitations are summarized in Table 2, whereas details on the evidence base for each outcome are provided in Table II in the Data Supplement.

The studies show that life on MCS required major adjustment for both patients and their caregivers, and that the early experience could be frightening and overwhelming.28–30 Despite a new lease on life offered by the treatment, MCS affected multiple aspects of life, including hygiene, sleep, the environment, daily routines, and personal and intimate relationships.28,31 An initial adjustment period of ≈3 months was difficult for both MCS recipients and informal caregivers.28,30 Informal caregivers, who described caregiving as a 24/7 responsibility, settled into their role and new lifestyle with time.28,30 Most MCS recipients reported being satisfied with intimate relations after implantation, after various adaptations and self-care behaviors.

Table 2. Patient/Caregiver Perspectives on Daily Life With MCS

<table>
<thead>
<tr>
<th>What We Know</th>
<th>What We Do Not Know</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lifestyle adaptation</strong></td>
<td>Except for the study on psychological disorders, we do not have much information specific to DT patients (or their caregivers) unless indicated because the investigations include patients bridged to transplant</td>
</tr>
<tr>
<td>Adjustment took time</td>
<td>We do not know whether the results for recipients in these research studies are applicable to most DT patients. For example, study participants may do better or worse than other patients</td>
</tr>
<tr>
<td>Poor quality of life and major limitations before MCS</td>
<td>We do not know whether the caregiving results are applicable to most caregivers of DT patients or to male caregivers</td>
</tr>
<tr>
<td>Positive feelings on MCS as well as awe, dismay, feeling overwhelmed about care</td>
<td>We do not know how reproducible the results on caregiving,30 sex/intimacy,31 and psychological disorders34 are because they come from single studies</td>
</tr>
<tr>
<td>Early adjustment involved changes in hygiene, sleep, home environment, clothing, routines, personal relationships, socialization, and employment</td>
<td></td>
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<tr>
<td>Early fear, anxiety, and low self-confidence</td>
<td></td>
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<tr>
<td>Adjustment process difficult for many recipients</td>
<td></td>
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<tr>
<td>Late adjustment (after 3 mo) involved accepting a new way of living. DT patients reported positively embracing MCS</td>
<td></td>
</tr>
<tr>
<td>Feelings reported by recipients: facing the unknown, feeling confined (in hospital; because of dependence on others), shame when out with the device, overwhelming fear, and hope for the future</td>
<td></td>
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<tr>
<td>Despite difficulties, would accept MCS again</td>
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<tr>
<td><strong>Adjustment to caregiving</strong></td>
<td></td>
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<tr>
<td>Caregiving a 24/7 responsibility</td>
<td></td>
</tr>
<tr>
<td>Feelings reported by caregivers: hyper-vigilance, less time for personal activities, settling into role with time, adjusting was overwhelming in first 3 mo</td>
<td></td>
</tr>
<tr>
<td>Caregiving extended beyond technical tasks to a supportive role, requiring a new lifestyle and coping strategies; satisfaction with caregiving developed with time</td>
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<tr>
<td><strong>Sex and intimacy</strong></td>
<td></td>
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<tr>
<td>Improved sexual functioning after MCS</td>
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<tr>
<td>Most recipients satisfied with their sexual relations and intimacy</td>
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<tr>
<td>Adaptations and self-care behaviors used to maintain normal intimate relations</td>
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<tr>
<td>Most recipients reported partners being fearful of sex; some partners wanted to abstain</td>
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<tr>
<td><strong>Sleep</strong></td>
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<tr>
<td>Significant sleep disturbances before MCS and at 6 mo of support</td>
<td>We do not know whether patients on MCS seen by a psychologist differ from those not seen</td>
</tr>
<tr>
<td>Short sleep duration and quality before MCS and at 6 mo of support</td>
<td></td>
</tr>
<tr>
<td>Average total sleep time: 4.2 h before MCS and 4.6 h at 6 mo</td>
<td></td>
</tr>
<tr>
<td>At 6 mo, significant improvement in overall quality of life, modest improvement in sleep quality, and daytime alertness</td>
<td></td>
</tr>
<tr>
<td><strong>Psychological disorders</strong></td>
<td></td>
</tr>
<tr>
<td>Diagnoses among DT patients seen by a psychologist in the postoperative period: adjustment disorder (47%), acute stress reaction (20%), depressive episode (20%), panic disorder (7%), and 13% had no disorder</td>
<td></td>
</tr>
</tbody>
</table>

DT indicates destination therapy; and MCS, mechanical circulatory support.
Device Deactivation and Other End-of-Life Issues

Documented end-of-life care planning, in general, and explicit discussions about device deactivation, in particular, are recommended before MCS. There is a consensus in American and European position statements that patients (or their surrogate decision makers) have the right to request active discontinuation of MCS. This differs from assisted suicide and euthanasia because the intent is ending a treatment that is preventing natural progression of a pre-existing disease. Recent position statements highlight the importance of involving a collaborative, multidisciplinary team in end-of-life care planning and the central role of palliative care professionals in these discussions.

From a total of 108 citations identified by our literature search, we retained 5 articles pertaining to end-of-life issues. This literature was very limited: studies were small (14–68 persons), and 4 were from single sites (3 from the same hospital). Two studies involved exclusively DT patients. Patients varied in age from 19 to 83 years; 86% were men. Results and their limitations are summarized in Table 3, whereas details on the evidence base for each outcome are provided in Table III in the Data Supplement. Table 3 lists some examples of issues that were not addressed by the available literature that include optimal timing of discussions and psychological effects.

The studies show that DT patients were more likely to have documented care directives in their medical charts than if they were formally involved in advance care preparedness planning, and that palliative care consultations for patients using MCS (≥60% DT) were both appreciated and associated with increased clarity about treatment plans. A 2003 to 2009 study (≥50% DT) found that none of the care directives of MCS patients in medical charts specifically mentioned the circumstances in which MCS might be deactivated. However, requests to terminate MCS were not uncommon: at the same center from 2003 to 2009, such requests were made for 21% of recipients (50% of these DT), usually by surrogate decision makers (85% of the time), because the patients no longer had decision-making capacity. Two studies we reviewed, one exclusive to DT, reported that decision making about terminating MCS was facilitated by open discussions with a multidisciplinary care team and by care providers giving detailed information about the deactivation process and palliative treatments. Most DT patients who actively participated in deactivation decisions had experienced a decline in quality of life because of clinical or functional deterioration.

Discussion

This perspective focuses on information transfer as an integral part of the decision-making process for patients considering long-term MCS and for whom subsequent heart transplantation is unlikely. Like the informed consent process itself, the exchange of information between care providers and patients should be bidirectional, timely, comprehensive, and responsive to changes in patient preferences and clinical course. We have summarized the current status of the scientific evidence in DT on 3 overarching topics. Information on clinical outcomes for DT patients is relatively plentiful. However, there is much less scientific literature about the impact of MCS on daily life for recipients and their informal caregivers/family. Nonetheless, this limited literature provides valuable information on the lived experience, including the ending of treatment. For all 3 topics, current data apply mostly to men. Sex-specific analyses among transplantation-eligible patients indicate similar clinical benefits in women and men, but differences in risks of adverse events.

The unknowns that we have identified included gaps in knowledge, where information is lacking, and the applicability of findings from groups of research or registry participants to the individual patient considering MCS. For a DT candidate with advanced heart failure, his/her own clinical course, with or without MCS, is somewhat uncertain. Perhaps the most critical gap in knowledge for DT relates to the difficulty in precisely predicting who will achieve clinical and quality-of-life benefits afforded by long-term MCS and who will experience life-altering complications. There is a pressing need for predictive models that go beyond survival to guide patient decision making.

Our results capture the state of the science as of early 2013. We searched peer-reviewed scientific publications and did not explore information available from other sources. Nevertheless, we have combined results from multiple themes and sources (eg, research studies, registries, and qualitative investigations). We have focused on patients considering MCS as DT rather than other indications such as bridge-to-transplantation. We appreciate that these categories are neither strictly distinct nor always easily discernible in clinical practice.

Information transfer to patients is only 1 component of the decision-making process. Other aspects are careful, individualized assessment of the patient’s clinical, social, and psychological state; the use of risk models to assist with prognosis; and broader discussion about the goals of care. A scientific statement from the American Heart Association on decision making in advanced heart failure provides advice and tools addressing communication and the doctor–patient relationship. The complexity and time-consuming nature of treatment discussions in MCS and particularly DT is recognized, and decision aids are suggested to assist with the presentation of numeric data (such aids are conceived as more than simple information pamphlets).

Training for physicians in communication methods and a supportive environment for multidisciplinary, patient-centered care are
recommended. And perhaps one of the most important elements in clinical encounters is helping the patient recognize that uncertainty persists in modern medicine. Indeed, these considerations highlight the inherent relativity of the fully informed concept, given the imponderables and the uniqueness of each patient with advanced heart failure.

In this perspective, we have presented what we believe is the most comprehensive examination of the outcomes and experiences of DT patients in the scientific literature to date. The summaries of the themes herein presented may serve as the basis for an information tool for care providers to use with patients considering long-term MCS and with their informal caregivers. Such work will likely become increasingly relevant as waiting times for heart transplantation lengthen, availability of donor organs diminishes, and more and more patients are offered MCS as ultimate treatment for severe heart failure.

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Disclosures
None.

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### Supplemental Table S1. Benefits and risks: evidence base

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Who this is based on</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SURVIVAL at 1 year</strong></td>
<td>Registry(^1) of 1694 recipients of a CF device* as DT and 1 DT research study(^2) of 281 HM II recipients.</td>
</tr>
<tr>
<td><strong>at 2 years</strong></td>
<td>Same sources as above</td>
</tr>
<tr>
<td><strong>NYHA CLASS at 1 year</strong></td>
<td>2 DT research studies(^2,4) of 393 HM II recipients evaluated at baseline (before implantation) and 276 evaluated at 6 months</td>
</tr>
<tr>
<td><strong>at 2 years</strong></td>
<td>Same sources; 153 patients evaluated at 2 years</td>
</tr>
<tr>
<td><strong>6-MINUTE WALK DISTANCE at 6 months</strong></td>
<td>2 DT research studies(^2,4) of 150 HM II recipients evaluated at baseline and 221 evaluated at 6 months</td>
</tr>
<tr>
<td><strong>at 2 years</strong></td>
<td>Same sources; 134 patients evaluated at 2 years</td>
</tr>
<tr>
<td><strong>ACTIVITY LEVEL at 6 months</strong></td>
<td>2 DT research studies(^2,4) of 365 HM II recipients evaluated at baseline and 254 evaluated at 6 months. (reported by Rogers et al.(^5))</td>
</tr>
<tr>
<td><strong>at 2 years</strong></td>
<td>Same sources; 101 patients evaluated at 2 years</td>
</tr>
<tr>
<td><strong>END-ORGAN FUNCTION at 6 months</strong></td>
<td>1 DT research study(^6) of 72 patients† evaluated both at baseline and at 6 months.</td>
</tr>
<tr>
<td><strong>at 2 years</strong></td>
<td>Same source; 33 patients† evaluated both at baseline and at 2 years</td>
</tr>
</tbody>
</table>

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* CF device* does not exist. 
† Data on 72 patients evaluated at baseline and 33 patients evaluated at 2 years. 
\(^1\) Registry: 2006-2012, 114 US centers; almost all HM II; data for 1160 DT patients implanted in 2006-2011 in 104 US centers\(^3\): average patient age 63.6; average BSA 2.04 m\(^2\); 11% cardiogenic shock. 
\(^2\) Research patients: 2007-2009, 38 US centers; average age 63.3; 79% male; average BSA 1.96 m\(^2\); 78% on inotropes. 
\(^3\) Registry: 2006-2012, 114 US centers; almost all HM II; data for 1160 DT patients implanted in 2006-2011 in 104 US centers\(^3\): average patient age 63.6; average BSA 2.04 m\(^2\); 11% cardiogenic shock. 
\(^4\) Average patient age ≈63; 79% male (data for all 414 patients who received a HM II in 2005-2009 in 38 US centers). 
\(^5\) Average patient age ≈63; 79% male (data for all 414 patients who received a HM II in 2005-2009 in 38 US centers). 
\(^6\) Average patient age ≈63; 79% male (data for all 414 patients who received a HM II in 2005-2009 in 38 US centers). 

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At baseline, average patient age 61; 73% male; average BSA 2.0 m\(^2\); 76% on inotropes; 20% prior stroke (data for 96 HM II patients tested at baseline).
QUALITY OF LIFE at 6 months

Registry\(^1\) of CF DT recipients: 852 persons evaluated at baseline and 466 evaluated at 6 months (general quality of life test)

2 DT research studies\(^2,^4\) of 360 HM II recipients evaluated at baseline and 270 evaluated at 6 months (tests specific to heart failure)

at 1 year

Same sources; 230 research study patients and 281 registry recipients evaluated at 1 year

at 2 years

Same research studies; 161 research study patients evaluated at 2 years

INITIAL HOSPITALIZATION

1 DT research study\(^5\) of 281 HM II recipients; 1 earlier DT research study\(^4,^7\), 134 patients randomly assigned to receive HM II.

HOSPITAL READMISSIONS: time spent in hospital

1 DT research study\(^8\) of 134 patients randomly assigned to HM II.

Rate and causes of readmissions

1 research study\(^7\) of 73 DT HM II patients (this sample likely overlaps somewhat with an earlier study of 281 HM II recipients\(^5\))

ADVERSE EVENTS: % of recipients affected

2 DT research studies\(^2,^4\) of 414 HM II recipients who were observed for an average support duration of 20.5 months per person. Data on respiratory failure and hepatic dysfunction are available from one of these studies\(^4\) (133 patients observed for an average support duration of 19 months per person).

Registry: At baseline, average patient age \(\approx 64\) (data for all 1160 DT patients implanted in 2006-2011 in 104 US centers\(^3\))

Research patients: At baseline, average age \(\approx 63\); 79% male (data for all 414 patients who received a HM II in 2005-2009 in 38 US centers)
Data on timing of events from 1 research study\(^8\) of 281 HM II bridge-to-transplant recipients observed for an average support duration of 7.8 months, and from 169 registry patients\(^9\) who received HM II as bridge to transplant and were observed for an average support duration of 10.1 months.

At baseline, average patient age 50; 76% male; received HM II in 2005-2008 in 33 US centers

At baseline, patients aged 40-59 years; 78% male; received HM II in 2008 in 77 US centers

% of recipients readmitted to hospital for each type of event

1 research study\(^7\) of 73 DT HM II patients who were observed for an average support duration of 18 months per person (this sample likely overlaps somewhat with an earlier study of 281 HM II recipients\(^2\))

At baseline, average age \(\approx 62\); 83% male; average initial hospital stay 16 days; 65% on inotropes; 1 US center (data for all 115 patients discharged who received a HM II in 2008-2011; 42 patients were transplant-eligible)

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CF: continuous flow; DT: destination therapy; HM II: HeartMate II®; MCS: mechanical circulatory support; US: United States of America; BSA: body surface area; NYHA: New York Heart Association; min: minimum; max: maximum

*We assume the continuous-flow devices in INTERMACS are almost exclusively HeartMate II®.

†Sample size is the smallest number of patients tested for the various domains.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Who this is based on</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIFESTYLE ADAPTATION</strong></td>
<td>Research study(^{10}), 1 US hospital; recruitment in 2009-2010 Patients selected if on support for (\geq 3) months, out of hospital; interviewed in person for 15-102 minutes in outpatient clinic; asked about experience of living with MCS, lifestyle adjustments and adjustment strategies 7 men, 2 women; aged 31-70 years (average 56); 0.5-4 years of support with HM II; most Caucasian, high school graduates, married, had a family caregiver 7 were transplant-eligible; 2 men were DT patients, supported for 1 and 3.5 years, aged 56 and 66</td>
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<td>Research study(^{11}), 1 US hospital Patients selected if were implanted in previous year Patients interviewed in person for 45-90 minutes in their homes; asked about living with MCS, how daily life had changed and other issues considered important to them 2 men, 4 women; aged 42-76 years (average 59); 1-13.5 months of support (likely HM II); most were Caucasian, married; 5 had received a heart transplant by time of interview; 1 had chosen DT All lived within a 3-hour drive of hospital</td>
</tr>
<tr>
<td><strong>ADJUSTMENT TO CAREGIVING</strong></td>
<td>Research study(^{12}), 1 US hospital Caregivers selected if had cared for a MCS recipient at home for (\geq 3) months; interviewed in person for 24-62 minutes in out-patient clinic; asked about their lifestyle adaptations and the meaning of MCS caregiving 5 women; aged 39-71 years Most were Caucasian, college educated, married, give care 24 hours/day 1 caregiver of a DT patient 4 caregivers of transplant-eligible patients</td>
</tr>
<tr>
<td><strong>SLEEP</strong></td>
<td>Research study(^{13}), 1 US hospital; recruitment in 2008-2009 Patients selected if MCS candidates; no sleep disorders Patients completed diaries/questionnaires and wore a wrist device to measure sleep for 3 days (at home), before MCS and up to 6 months after) 9 men, 4 women; average age 55 years Most were Caucasian, college educated, married 3 DT patients; 8 transplant-eligible (1 received a heart after 5 months); 2 bridge-to-decision (BTD) All had stage D heart failure</td>
</tr>
<tr>
<td></td>
<td>Research study(^{14}), 1 US hospital; recruitment in 2008-2010 Patients completed standardized questionnaires before MCS and after 6 months, at the hospital 8 men, 4 women; average age 54 years; all HM II Almost all the same patients as above (but no heart recipient nor BTD); most patients NYHA class IV</td>
</tr>
<tr>
<td>SEX AND INTIMACY</td>
<td>Research study, 1 US hospital</td>
</tr>
<tr>
<td>PSYCHO-LOGICAL DISORDERS</td>
<td>Research study, 1 hospital in Germany; all MCS patients offered psychological services</td>
</tr>
</tbody>
</table>

HM II: HeartMate II®; MCS: mechanical circulatory support; US: United States; DT: destination therapy; NYHA: New York Heart Association; ICD-10: International Classification of Diseases version 10
Supplemental Table S3. MCS deactivation and other end-of-life issues: evidence base

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| PALLIATIVE CARE (PC) CONSULTATION AND ADVANCE DIRECTIVES (AD) | Research study<sup>17</sup>, 1 US hospital  
All DT patients were offered a standardized, integrated PC consultation for “advance care planning” in 2009-2010, before implantation or shortly afterwards  
Medical charts of all DT patients were reviewed  
Research study<sup>18</sup>, 1 US hospital  
Medical charts of all MCS recipients from 2003-2009 were reviewed (before start of PC consultation service)  
Research study<sup>19</sup>, 1 US hospital  
Medical charts of the first 20 patients who received a PC consultation in 2009-2010 were reviewed; patients/families asked about the impact of the PC consultation service  
Termin- ation of MCS | 16 men, 3 women; aged 55-78 years (median 70.9); all HM II and all DT patients  
All patients NYHA class IIIb/IV; average duration of heart failure: 5.9 years  
56 men, 12 women; average age 59 years; mostly Caucasian, some college education, married  
33 DT and 32 transplant-eligible patients; 3 implanted as bridge-to-recovery; 78% of devices continuous flow, otherwise pulsatile  
18 men, 2 women; aged 19-83 years (average 54)  
4 DT patients  
Most patients required transient inotropic support  
13 men, 1 woman; aged 41-68 years (median 57); length of support 1 day to 2.8 years (median 64 days); 7 DT patients (all men; 48-68 years; 2 with CF device; 16 days to 2.8 years of support)  
DT patients: 18 men, 2 women; aged 23-82 years (average 67); 2.5 months to 4.8 years of support (pulsatile devices)  
Caregivers were mostly spouses; 2 were adult children; 1 was a parent |

HM II: HeartMate II®; MCS: mechanical circulatory support; US: United States; DT: destination therapy; PC: palliative care; AD: advance directives; CF: continuous flow
REFERENCES


