End-stage heart failure in children or patients suffering from congenital heart disease: are new treatment options emerging?

Oliver Miera, Evgenij V. Potapov and Felix Berger

The development and time course of end-stage heart failure in paediatric patients suffering from cardiomyopathy and in patients suffering from repaired and unrepaired congenital heart defects are different from those of the adult population, since the myocardial damage is mainly not of an ischaemic nature. Therefore, the approach needed to treat end-stage heart failure in these patient groups is different from that in adult patients with end-stage heart failure due to coronary artery disease, cardiomyopathy or myocarditis. As in adults with acquired heart diseases, heart transplantation (HTx) and mechanical circulatory support (MCS) are the only two remaining options. However, due to issues of availability, the balance between the two options is different for children and the entire group of patients suffering from congenital heart disease (CHD).

There are three major factors that most strongly impact the decision algorithm in these patients. First, due to the dramatic improvements in paediatric cardiac surgery and postoperative care, including the subsequent interventional procedures, during the past decades there have been increasing numbers of patients surviving into adulthood, such as those with univentricular hearts, who may develop end-stage heart failure after years of nearly normal quality of life [1–3]. Additionally, a significant number of adult patients who received palliative procedures as children 30–40 years ago now bear a high risk of congestive myocardial failure [4]; many of them are adults who underwent Senning and Mustard repair of transposition of the great arteries or Fontan procedures in childhood [5, 6].

Secondly, the number of paediatric HTx has stagnated while the need for donor organs continuously increases [7].

Finally, the experience with MCS lasting beyond 5 years is limited and no patients, even adults, have been supported for >8 years, whereas many children survive for >20 years after HTx.

Therefore, HTx remains the gold standard in almost all children and represents the treatment of choice. However, a small proportion of children with acute myocarditis or even dilative cardiomyopathy may be better treated by MCS with subsequent weaning after remodeling of the myocardial textures and preservation of the patient’s own heart [8].

Based on these facts, the following scenarios are of special interest in the Eurotransplant area and should be discussed within the community:

(i) All children with end-stage heart failure should undergo primary HTx.

(ii) All children should primarily receive MCS as a bridge to HTx.

The first scenario is impossible due to mismatch between the waiting list and the number of donors available, as well as the fact that many of the children deteriorate on the waiting list and need emergency MCS due to the shortage of donor organs. The published data show an increase in the use of MCS by up to 25% [7]. In 2012, all children who received transplantation at our institution had previous ventricular assist device (VAD) support. In centres without the option of utilizing MCS the mortality on the waiting list may be significantly higher.

The second scenario raises some questions. For small children weighing <20 kg only the paracorporeal Berlin Heart Excor device is approved and currently available for commercial use. Experimental devices developed in the PUMPKIN project are still far from the clinical testing stage [9] and even further from routine use in the pediatric population. For children from 17 kg upwards the implantable HeartWare HVAD has been successfully used [10], even though the device is approved for patients with body surface area >1 m². The newly developed HeartWare MVAD will undergo clinical testing in adults starting in 2013. Its use in children in the weight range 10–15 kg might be possible, but is not to be expected within the next 3–5 years in Europe and definitely later in the USA and Canada. Therefore, the use of MCS in the paediatric age group is regionally limited to a small number of centres and can therefore not cover the global need.

The 10-year survival after HTx for children with CHD is ~60% [7, 11]. However, the waiting time for HTx at all ages has increased substantially in the Eurotransplant area. In 2002, <3% waited >2 years, while nowadays the proportion of these patients is 17% [7, 11]. At the same time, the long-term survival and quality of life with the currently available pediatric MCS systems...
are still far inferior to the good long-term results of HTx. Additionally, with increasing time on MCS support, the risk of the development of complications such as disabling stroke or severe infection, which preclude HTx, also increases [12]. It cannot be expected that current MCS devices or those that are under development will substantially change this situation in the next 5–10 years. Further, bridging to transplantation on MCS in children <14 years is combined with a continuous hospital stay and consequently suboptimal use of hospital resources. Therefore, MCS in children as final destination therapy does not seem to be a valid option today and in the near future. This raises questions of an ethical and social nature—who should be transplanted first: children without the need for MCS, children put on MCS in stable clinical condition in hospital or at home or those already on MCS and suffering from complications due to the MCS?

In our hospital, we currently do not distinguish among these groups under ethical considerations and all of these children are on the high urgency (HU) transplantation waiting list, if clinical judgment anticipates that transplantation will be successful. In this context, the most difficult decision is the judgment of the transplantability of children with neurological deficits, mainly due to complications from the MCS use. In such cases, the decision can only be made by an independent institutional ethics committee.

The GUCH (grown up CHD) patients with end-stage heart failure should be treated as patients with a high risk for HTx [11], but they are also placed on the waiting list if standard criteria are met. Many of these patients need specific transplantation management with regard to the explantation of the donor organs (long aortic arch segment/pulmonary bifurcation up to the hilar region included) and the technical aspects of the implantation of the organ. Some of them need complex reconstruction of the anatomy to create a biventricular circulation (hypoplastic left heart syndrome or tricuspid atresia or any type of univentricular heart after Fontan completion, dextrocardia etc.). If GUCH patients are not eligible for HTx or suffer decompensation while on the waiting list, MCS should be implanted [13] either as destination therapy or as bridging to transplant if this is technically possible. Destination therapy is a valuable option in those patients who are not candidates for transplantation and should be discussed early on as an alternative to palliative care. Several problems, however, including severe adhesions, single-ventricle anatomy, bleeding complications or severe arrhythmia may impact the postoperative survival.

In conclusion, primary HTx remains today and for the near future the best option for children with end-stage heart failure and everything possible has to be done to improve donor-organ availability. However, the paracorporeal MCS devices should be employed earlier, before the onset of multi-organ failure, if the systemic circulation acutely fails. Nevertheless, this treatment option is still to be regarded as a bridge to transplantation and cannot serve as a final destination therapy in this particular patient population. In children >20 kg, implantable devices should be preferably used, also serving as a bridge to transplantation. Patients with congenital heart defects, particularly those with single-ventricle anatomy, represent a still very challenging patient group, where the technical challenges and possibilities will decide which treatment may be best, if primary HTx is not feasible. In GUCH patients, MCS as a final destination should be more liberally taken into consideration, since HTx in these patients carries a significantly higher perioperative mortality, and this probably balances the outcome of transplantation with MCS as destination therapy.

REFERENCES