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ORIGINAL ARTICLE

Unrelated cord blood transplantation in adults with myelodysplasia or secondary acute myeloblastic leukemia: a survey on behalf of Eurocord and CLWP of EBMT

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The aim of our study was to evaluate, through the Eurocord and European Group for Blood and Marrow Transplantation (EBMT) registries, outcomes and risk factors for outcomes in adult patients who underwent single or double unrelated cord blood transplantation (UCBT) for myelodysplastic syndrome (MDS) or secondary acute myeloblastic leukemia (sAML). A total of 180 adults with MDS ($n=39$) or sAML ($n=69$) were analyzed. Risk factors for outcomes were analyzed using the Fine and Gray method and the Cox model. Median age was 43 (18–72) years. In all, 77 patients (71%) received a single UCBT. Myeloablative conditioning regimen (MAC) was given to 57 (53%) patients. Median numbers of nucleated and CD34$^+$ cells at freezing were 3.6×10^7 and 1.1×10^5 kg. At 60 days, cumulative incidence of neutrophil recovery was $78\pm4\%$ and was independently associated with the number of CD34$^+$ cells per kg ($>1.1\times10^5$; $P=0.005$) and advanced disease status (blasts $<5\%$ at time of UCBT, $P=0.016$). A 2-year non-relapse mortality (NRM) was significantly higher after MAC (62 vs 34%; $P=0.009$). A 2-year disease-free-survival (DFS) and overall survival (OS) were 30 and 34%, respectively. In multivariate analysis, patients with high-risk disease (blasts $>5\%$ and International Prognostic scoring system (IPSS) intermediate-2 or high in MDS) had significant poorer DFS (hazard ratio (HR): 1.76; $P=0.047$). In spite of high NRM, these data indicate that UCBT is an acceptable alternative option to treat adults with high-risk MDS or sAML, without a suitable human leukocyte antigen (HLA)-matched donor.

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Introduction

Since the publication of encouraging results with unrelated cord blood transplantation (UCBT) in early 2000, this procedure has been used with increasing frequency in patients lacking an human leukocyte antigen (HLA)-matched donor.[1–3] The main advantages of UCBT include rapidity of availability and the possibility of using partially HLA-mismatched UCB units without high risk of graft vs host disease (GVHD). The limiting factor is an engraftment rate of around 70–90%, which is highly influenced by total nucleated and CD34$^+$ cell dose at UCB collection.[4] To overcome this obstacle, double UCBT has been successfully performed.[5] UCBT, initially reserved to children, has been more frequently used in adults because of the use of double UCBT.[6] For patients with acute leukemia, UCBT is currently accepted as an alternative source in patients lacking HLA-matched unrelated donor. In contrast, up to now, few data exist for patients with myelodysplastic syndrome (MDS). Patients with MDS or secondary acute myeloblastic leukemia (sAML) respond very poorly to chemotherapy and in higher risk patients, survival is below 10% at 2 years.[7–9] New medications such as demethylating agents have shown some hematological and survival improvements,[10–13] but allogeneic hematopoietic stem cell transplantation (HSCT) remains indicated in high-risk patients aged <60 years.[14–16] Unfortunately, only 40–50% of patients will have a suitable HLA-matched donor. UCBT has been used as an alternative for some patients lacking an adult donor. The aim of this study was to evaluate outcomes of adult patients reported to the Eurocord and European Group for Blood and Marrow Transplantation (EBMT) registries, who received single or double UCBT for MDS or sAML.

Materials and methods

Data collection and population

Eurocord is an International registry operating on behalf of the European Blood and Marrow Transplant (EBMT). Participation in this study was open to European and non-European centers performing UCBT. The median number of patients reported by each center was 1 (range: 1–16). A total of 27 patients have been previously published.[17] The study included all consecutive patients receiving UCBT between January 1997 and December 2008, who were 18 years old or more and were diagnosed with MDS or sAML at time of transplantation. Patients with AML secondary to MDS or therapy-related leukemia were included because their prognoses are usually considered similar. Patients who had received previous allogeneic hematopoietic stem cell transplant (HSCT) or a manipulated (*ex vivo* expansion) UCBT were excluded. Data regarding patient, disease and transplant characteristics and clinical outcomes were collected by

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standardized questionnaire for each UCBT recipient. For MDS, the questionnaire included MDS characteristics not only at diagnosis and at the time of UCBT, but also at worst status. A total of 108 patients met the above eligibility criteria.

Definitions

MDS and AML were classified according World Health Organization criteria. Patients with chronic myelomonocytic leukemia were also included in the study. The possible diagnoses for patients were: refractory anemia with or without ringed sideroblast, refractory cytopenias with multilineage dysplasia with or without ringed sideroblasts, refractory anemia with excess of blasts 1 (5–10%) and 2 (11–19%), unclassifiable MDS, MDS associated with isolated 5q−, chronic myelomonocytic leukemia and AML. Classification and calculation of International Prognostic scoring system (IPSS) were performed at the time of diagnosis, worse status and transplantation. Cytogenetic classification was defined according to the Medical Research Council classification for AML[18] and the IPSS score for MDS.[19] Secondary acute leukemia was either transformed from MDS or therapy-related AML. At the time of UCBT, patients were classified as having high-risk disease if they had AML not in first or second remission or MDS with intermediate-2 or high IPSS score and disease with >5% blasts in bone marrow. Worst status of MDS was defined as either transformation into AML or the highest documented bone marrow blast count between diagnosis and UCBT. Donor–recipient HLA compatibility was determined by serology level typing for HLA-A and -B and by high-resolution allele level typing for HLA-DRB1. Transplants were classified as HLA mismatched with 1, 2, 3 or 4 differences if disparities were detected in HLA-A, -B or -DRB1.

The date of neutrophil engraftment was defined as the first of 3 consecutive days with neutrophil counts $>0.5\times10^9$/l. Platelet engraftment was defined as the first of 7 consecutive days with platelet counts $>20\times10^9$/l without transfusion. Primary graft failure was diagnosed when the neutrophil engraftment end point was not reached by day 60 or when a second transplant for non-engraftment was performed.

Determination of the comorbidity score was assigned using an HSCT-specific comorbidity index.[20]

GVHD was diagnosed and graded according to standard criteria.[21,22]

Relapse was defined on the basis of morphological evidence of MDS or AML in bone marrow or in tissue or organ (chloroma).

Statistical analysis

The end points were engraftment, acute GVHD (aGVHD), relapse, overall survival (OS), event-free survival and non-relapse mortality (NRM). All time-to-event data were calculated from the date of transplantation to the date of the event or last follow-up, whichever occurred first. NRM was defined as death without relapse and was analyzed in a competing risk setting, with relapse being treated as the competing event. Engraftment and acute and chronic GVHD were also analyzed in a competing risk setting, with death as competing events.

The cumulative incidences (CIs) of engraftment, acute and/or chronic GVHD, relapse and NRM were estimated using the Gray method. The probabilities of OS and event-free survival were estimated using the Kaplan–Meier method.[23] Covariates considered were age, diagnosis at the time of UCBT (MDS, AML), disease risk (high risk, low risk), period of transplant (1998–2005 vs 2006–2008), recipient cytomegalovirus serostatus, median number of nucleated cells infused, conditioning regimen (reduced intensity conditioning regimen (RIC) or myeloablative conditioning regimen (MAC)), recipient gender, GVHD prophylaxis (cyclosporine plus steroids vs cyclosporine plus mycophenolate), use of antithymoglobulin before UCBT, number of UCB units (single vs double), median time from diagnosis to UCBT, HLA disparity, number of total nucleated and $CD34^+$ cells collected and infused. Multivariate models for outcomes were performed using the Fine and Gray method[24] for engraftment, acute and chronic GVHD, relapse and NRM and using the Cox model[25] for OS and DFS. Multivariate models were constructed using a forward selection procedure and only variables that attained a *P*-value $\leqslant0.10$ in univariate analysis were entered in the final model. All tests were two-sided. Statistical analyses were performed with SPSS 15.0 statistical software (SPSS, Chicago, IL, USA), Splus 6.1 (MathSoft, Seattle, WA, USA).

Results

Patient, disease and donor characteristics

Median patient age was 45 years (range, 18–72); 45 (42%) were men and 74 (69%) had positive cytomegalovirus serology before transplantation. Disease characteristics are shown in Table 1.

Table 1 Disease characteristics

Disease characteristics	
Number of patients	108
Characteristics at diagnosis	
WHO classification	
RA or RCMD ± SR	16
RAEB1	19
RAEB2	31
Chronic myelomonocytic leukemia	10
Myelodysplasia unclassified or unknown	7
Therapy-related acute myeloid leukemia	25
Cytogenetics	
Myelodysplasia	83
Favorable, no. (%)	28 (34)
Intermediate, no. (%)	18 (22)
Poor, no. (%)	25 (30)
Missing or incomplete, no. (%)	12 (14)
Therapy-related acute myeloid leukemia	25
Favorable, no. (%)	1 (4)
Intermediate, no. (%)	15 (60)
Poor, no. (%)	6 (24)
Missing or incomplete, no. (%)	3 (12)
Evolution from diagnosis to transplantation	
Myelodysplasia transformed into AML, no. (%)	44 (53)
t-AML achieving first complete remission, no. (%)	18 (72)
Time from diagnosis to transplantation, months (range)	9 (2–158)
Status at the time of transplantation	
All patients	
Bone marrow blasts <5%, no. (%)	58 (54%)
Missing, no. (%)	8 (7%)
t-AML and myelodysplasia transformed into AML, no.	69
First or second remission, no.	42
IPSS for myelodysplasia non-transformed into AML	
Low	7
Intermediate-1	11
Intermediate-2	7
High	6
Missing	8

Abbreviations: AML, acute myeloblastic leukemia; IPSS, International Prognostic scoring system; RA, refractory anemia; RAEB, refractory anemia with excess blasts; RCMD, refractory cytopenias with multilineage dysplasia; RS, ringed sideroblast; t-AML, therapy-related AML; WHO, World Health Organization.

A total of 25 patients had therapy-related AML secondary to the treatment of breast cancer ($n=9$), lymphoma ($n=5$), acute lymphoblastic leukemia ($n=3$) or other cancers ($n=8$). Maximum bone marrow blast counts before UCBT were >5% in 69 (92%) and >10% in 59 (78%) of the 75 evaluable MDS patients. In all, 45 of the 49 assessable patients with sAML received chemotherapy before transplantation. At time of transplantation, 42 (61%) patients with sAML were in first or second complete remission, 2 (3%) were in third complete remission and 25 (36%) had progressive disease.

Comorbidity score was available in 75 patients, and 42 patients had at least 1 comorbidity. Patients with comorbidities were older (51 vs 39 years) and received a RIC (79 vs 36%) more frequently. Conditioning regimens and GVHD prophylaxis are shown in Table 2. MAC consisted of cyclophosphamide with either total body irradiation (TBI) >6 Gy ($n=20$) or busulfan >8 mg/kg ($n=12$). RIC was based on fludarabine in all but three patients combined with low-dose TBI (⩽2 Gy) in 33 (65%) patients. A total of 49 (86%) MAC patients and 18 (35%) RIC patients also received antithymoglobulin. In all, 11 (51%) MAC patients and 41 (72%) RIC patients received GVHD prophylaxis consisting of cyclosporine and mycophenolate. UCBT characteristics are shown in Table 2.

Table 2 Preparative regimen and cord blood transplant characteristics

	Single	*Double*
No.	77	31
Median weight (range)	62 (39–97)	75 (45–108)
Conditioning regimen		
Reduced intensity, no. (%)	29 (37)	22 (71)
Use of antithymoglobulin or antilymphoglobulin, no. (%)	51 (66)	16 (52)
GVHD prophylaxis		
Cyclosporine and mycophenolate	30 (39)	22 (71)
Cyclosporine and steroids	37 (48)	6 (19)
Other	10 (13)	3 (10)
Sex match, no. (%)	37 (48)	13 (42)
ABO blood group		
ABO match, no. (%)	32 (42)	4 (13)
ABO minor mismatch, no. (%)	19 (25)	11 (36)
ABO major mismatch, no. (%)	23 (30)	15 (48)
Missing, no. (%)	3 (4)	1 (3)
HLA disparities (HLA-A and -B low resolution and -DRB1 allelic typing)		
0, no. (%)	3 (4)	1 (3)
1, no. (%)	29 (37)	5 (16)
2, no. (%)	44 (57)	19 (61)
3, no. (%)	0	2 (6)
Median number of collected blood cells		
Nucleated cells, $\times 10^7$/kg (range)	3.4 (1.9–7.3)	4.6 (2.9–7.6)
Missing	3	2
$CD34^+$ cells, $\times 10^5$/kg (range)	1.4 (0.2–5)	2 (0.6–3.9)
Missing	5	5
Median number of infused cord blood cells		
Nucleated cells, $\times 10^7$/kg (range)	2.6 (0.7–6.8)	3.4 (1.6–5.8)
Missing	3	7
$CD34^+$ cells, $\times 10^5$/kg (range)	1.2 (0.2–5.1)	1 (0.3–3.6)
Missing	5	7
Follow-up, months (range)	30.9 (7–75)	13.8 (2–40)

Abbreviations: GVHD, graft vs host disease; HLA, human leukocyte antigen.

Engraftment

The CI of neutrophil recovery was 78 ± 4% at 60 days after UCBT with a median time to achieve more than 0.5×10^9/l neutrophils of 23 (6–51) days. In univariate analysis, neutrophil recovery was decreased in patients (1) for whom time from diagnosis to UCBT was >9.5 months (69 ± 6% vs 87 ± 5%; $P=0.02$), (2) who received $<1.1 \times 10^5$ $CD34^+$ cells/kg (67 ± 7% vs 86 ± 6%; $P=0.002$) and (3) who had >5% blasts in the bone marrow at the time of UCBT (67 ± 7% vs 86 ± 5%; $P=0.01$). Patients who received RIC had similar engraftment than those who received MAC. In multivariate analysis, bone marrow blasts and number of $CD34^+$ cells infused were associated with increased neutrophil recovery (blasts <5%, hazard ratio (HR): 1.91, 95% confidence interval (95% CI): 1.13–3.24, $P=0.016$; $CD34^+$ $>1.1 \times 10^5$ cells per kg, HR: 2.02, 95% CI: 1.23–3.31, $P=0.005$). Cumulative incidence of platelet recovery was 50 ± 5% at a median time of 50 days (9–348).

Acute and chronic GVHD

The CI of grade II, III or IV aGVHD at day 100 was 26 ± 4%. Severe aGVHD (III and IV) occurred in 12 (11%) patients. The CI of aGVHD at day 100 was 30 ± 5% and 17 ± 7% for single and double CBT recipients, respectively ($P=0.16$). Patient age (age <43 years, CI: 26 ± 6%; age >43 years, CI: 27 ± 6%) and type of conditioning regimen (RIC CI: 28 ± 6%; MAC CI: 25 ± 6%) were not statistically associated with aGVHD. In a multivariate analysis, none of the factors studied influenced the risk of aGVHD. Among patients who survived more than 100 days, chronic GVHD was observed in 19 patients; it was limited in 9 (47%) and extensive in 10 (53%) patients. The CI of 2-year chronic GVHD was 42 ± 8%.

NRM and relapse

A 2-year CI of NRM was 49 ± 5%. Results of the univariate analysis are listed in Table 3. In multivariate analysis, RIC (HR: 0.42; 95% CI: 0.24–0.76; $P=0.003$) and shorter time from diagnosis to UCBT (<9.5 months) were associated with lower NRM (HR: 0.54; 95% CI: 0.31–0.94; $P=0$ .03). Among patients who received a MAC, those who received TBI had higher NRM (84 ± 8% vs 53 ± 9%; $P=0.065$). TBI did not influence NRM in patients who received a RIC. Antithymoglobulin did not increase NRM. CIs of NRM by the type of conditioning regimen (RIC or MAC) are shown in Figure 1a.

A 2-year CI of relapse was 21 ± 4%. In multivariate analysis, risk factors associated with increased relapse incidence were RIC (HR: 2.45; 95% CI: 1.01–5.9; $P=0.045$) and high-risk disease (HR: 3.96; 95% CI: 3.95–12.44; $P=0$ .028).

OS and disease-free survival

The 2-year OS and DFS were 34 ± 5% and 30 ± 5% (Figure 1b). Table 3 lists the univariate analysis for DFS. In multivariate analysis, the only risk factor associated with better DFS was lower disease risk at the time of UCBT (HR: 0.57; 95% CI: 0.32–0.99; $P=0.047$). There was a trend of improved DFS when the number of $CD34^+$ cells collected per kg was higher than 1.1×10^5 (HR: 0.64; 95% CI: 0.39–1.06; $P=0.081$). In all, 20 patients died of relapse, infections were the main cause of death in 24 patients and were associated with GVHD in 9 or rejection in 4; hemorrhage was the cause of death in 5, respiratory failure in 4, multiorgan failure in 3 and other causes in 4 patients.

Table 3 Risk factors for 2-year non-relapse mortality and event-free survival

	Non-relapse mortality ± s.d.	P-*value*	*Disease-free survival ± s.d.*	P-*value*
Diagnosis				
Secondary leukemia	45 ± 6		31 ± 6	
Myelodysplasia	57 ± 9	0.12	28 ± 8	0.24
Blasts <5% at the time of CBT				
Yes	45 ± 7		34 ± 7	
No	49 ± 8	0.44	26 ± 8	0.23
Disease risk group at the time of CBT				
High risk	47 ± 6		23 ± 6	
Low risk	48 ± 9	0.75	46 ± 9	0.05
Median age				
<43 years	51 ± 7		30 ± 6	
⩾43 years	48 ± 8	0.65	31 ± 6	0.97
Year of transplantation				
Before 2006	52 ± 7		29 ± 6	
2006 and after	47 ± 8	0.46	28 ± 7	0.31
Conditioning regimen				
Myeloablative	62 ± 7		24 ± 6	
Reduced intensity	34 ± 7	0.009	37 ± 7	0.27
GVHD prophylaxis				
Cyclosporine + steroid	61 ± 8		24 ± 7	
Cyclosporine + mycophenolate	34 ± 7		42 ± 8	
Other	60 ± 14	0.0026	13 ± 9	0.10
Serotherapy				
No	34 ± 9		38 ± 9	
Yes	57 ± 6	0.12	26 ± 4	0.75
Number of cord blood units				
Single cord blood	52 ± 6		33 ± 6	
Double cord blood	42 ± 10	0.46	22 ± 9	0.44
Time from diagnosis to transplantation				
<9.5 months	34 ± 7		42 ± 6	
9.5 months or more	26 ± 6	0.065	56 ± 7	0.09
HLA disparities				
0 or 1 antigen mismatch	50 ± 9		30 ± 8	
2 or more antigens mismatch	47 ± 7	0.99	31 ± 6	0.76
Irradiation				
Yes	51 ± 7		28 ± 7	
No	47 ± 7	0.96	32 ± 7	0.82
CMV serology for recipient				
Positive	48 ± 6		33 ± 6	
Negative	49 ± 10	0.52	28 ± 8	0.86
Nucleated cell dose collected				
$<3.6\times10^7$/kg	54 ± 7		30 ± 7	
$\geqslant3.6\times10^7$/kg	43 ± 7	0.44	31 ± 7	0.94
$CD34^+$ cell dose collected[a]				
$<1.1\times10^5$/kg	62 ± 9		19 ± 7	
$>1.1\times10^5$/kg	42 ± 6	0.11	35 ± 6	0.08

[a]Missing data for 10 patients.
Abbreviations: CBT, cord blood transplantation; CMV, cytomegalovirus; GVHD, graft vs host disease; HLA, human leukocyte antigen.

Discussion

Up to now, studies reporting results of UCBT for MDS patients have been scarce.[17,26] Here, we report an International survey of patients who received UCBT for MDS or sAML. DFS was 30%, which appears to be comparable to DFS after HSCT using other types of donors in large multicentric studies in high-risk MDS patients.[16,27] In our study, early and late outcomes were

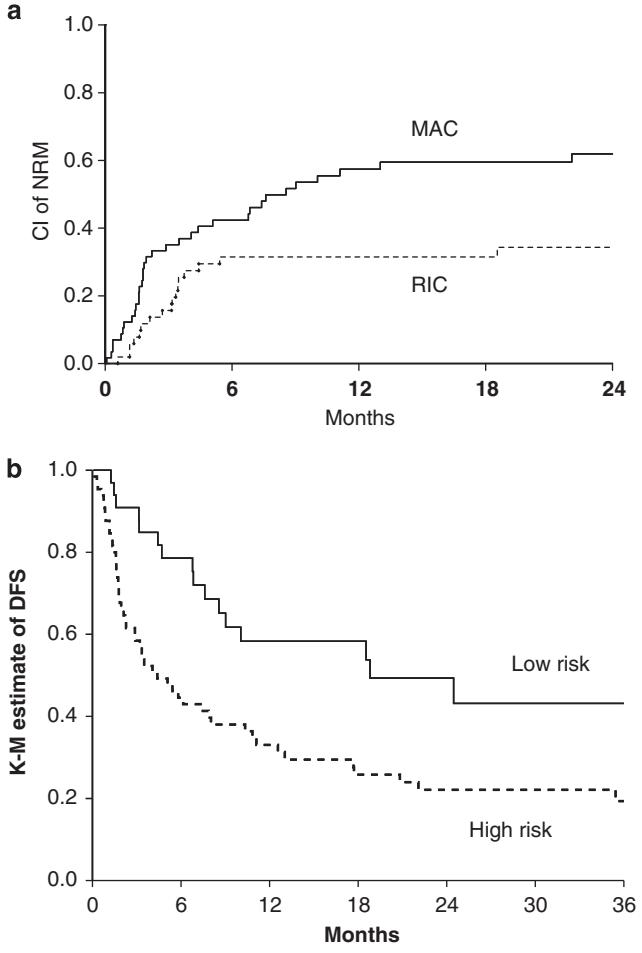

Figure 1 (**a**) Cumulative incidence of non-relapse mortality by conditioning regimen. Black line represents cumulative incidence of non-relapse mortality after MAC and dotted line represents cumulative incidence of non-relapse mortality after reduced intensity conditioning regimen. (**b**) Disease-free survival estimation by risk disease group. Black line represents disease-free survival in patients with lower risk disease (AML in remission, MDS with $<5\%$ blasts). Dotted line represents disease-free survival in patients with higher risk disease.

associated with the number of CD34 cells infused, type of conditioning regimen, the time from diagnosis to transplantation and, importantly, disease status at UCBT.

The advantage of our study is the relatively high number of patients included and the possibility to perform a risk factor analysis. However, as UCBT is not frequently performed in MDS patients, we analyzed a relatively heterogeneous group of patients receiving single or double UCBT following RIC or MAC performed in 47 centers. Currently, UCBT for MDS represents the minority of UCBT indications and consequently, a lot of participating transplant centers performing few transplants for MDS were included. Of note, MDS patients in this study were rigidly selected: they were relatively young, with relatively low weight and an aggressive disease, including transformation into acute leukemia in more than half of the patients, and in sufficiently good general health to undergo allogeneic transplantation.

Non-engraftment and delayed immune recovery are possible risks that currently limit indications for performing UCBT. A recent study has shown that neutrophil engraftment was decreased in children with MDS as compared with children with acute leukemia receiving UCBT.[28] In our study, the CI of neutrophil engraftment was 78% and it was associated with $CD34^+$ cell dose and blast count at the time of UCBT. A $CD34^+$ cell dose higher than 1.1×10^6/kg was the threshold found in our study associated with engraftment, in concordance with previous studies.[29,30] One could argue that the use of double cord blood transplantation could increase the probability of engraftment; however, this was not observed in our study. In fact, CD34 cell dose in double UCBT was equivalent to those in single UCBT, thus reflecting that double UCB grafts were used to overcome the lower cell dose contained in a single unit.

As expected, after UCBT, the CI of aGVHD was low. In contrast to a recent report,[31] patients who received double UCBT were not at greater risk for developing GVHD but these results should be interpreted with caution as the first double UCBT in this study was performed in 2001 and transplantation practices may have changed over time. For example, GVHD prophylaxis consisted of cyclosporine plus steroids in the majority of single UCBT recipients and cyclosporine plus mycophenolate in the majority of double UCBT recipients. Antithymoglobulin use before transplantation had no impact on GVHD occurrence (data not shown).

NRM remains important in UCBT and the most frequent cause of death is infection. Indeed, immune reconstitution is slower than in matched related donor transplanted patients, and infections are important complications.[32] In our study, time elapsed from diagnosis to UCBT and MAC increase were significant independent risk factors for NRM. A long delay before transplantation is often associated with multiple treatments and transfusions, increasing the risk of organ failure, infection, iron overload or more advanced disease. Disease duration before transplantation or iron overload has been regularly found to increase NRM and sometimes decrease survival in bone marrow or peripheral blood transplant recipients.[33–36] Our study confirmed that RIC before UCBT is associated with a reduction in NRM, as observed in unrelated HSCT recipients.[36]

Despite poorer general conditions and high-risk MDS, patients who received RIC had decreased NRM and a trend toward better DFS. The increased risk of relapse observed after RIC did not translate into poorer survival in our study despite a high proportion of patients with advanced disease. Furthermore, high-risk patients who received MAC had no survival advantage compared with high-risk patients who received RIC (data not shown). High-dose TBI appeared to result in particularly high NRM.

The most important risk factor for DFS was disease risk at the time of transplantation. These results raise the issue of pre-transplantation treatment to reduce disease tumor burden without postponing transplantation, which increases NRM. No randomized study exists to assess the role of chemotherapy before transplantation. New drugs such as demethylating agents are now widely used in MDS patients but very few data are currently available to analyze their impact before allogeneic transplantation.[37] Our results indicate that although it is better to transplant MDS patients with less active disease, patients who transform into secondary AML may still benefit from UCBT if they have achieved remission before transplantation. The Markov decision model in MDS patients with an HLA-identical sibling donor has shown that patients had a life expectancy advantage if they were transplanted before the AML occurrence,[38] but no such data exist for transplantation from an unrelated donor.

Our study shows that UCBT can be used in high-risk MDS patients. No data are currently available to determine whether

a mismatched unrelated donor is better or worse than UCBT in MDS adults, but HSCT remains the only curative treatment in advanced MDS patients. In acute or chronic leukemia, transplantation from an HLA-matched or one HLA allele-mismatched unrelated donor is associated with 5–10 and 10–15% lower survival rates, respectively, when compared with transplantation from an HLA-matched sibling donor, despite high resolution HLA typing.[39,40] With respect to the source of unrelated stem cells, HLA-mismatched bone marrow or cord blood transplants have been shown to give similar outcome in adults with acute leukemia.[2] Furthermore, outcomes with cord blood transplantation have been reported to be similar to that of HLA-matched bone marrow by Rocha *et al*.[3] but this was not confirmed by Laughlin *et al*.[2] In patients with MDS, DFS appears to be similar to that achieved using other unrelated hematopoietic stem cell sources, but comparative studies are required to better determine the role of UCBT for this group of patients.

Conflict of interest

The authors declare no conflict of interest.

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