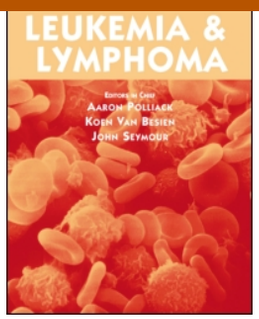

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Determinants of 1-year survival in critically ill acute leukemia patients: a GRRR-OH study

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ABSTRACT

Acute leukemia (AL) is the most common hematological malignancy requiring intensive care unit (ICU) management. Data on long-term survival are limited. This is a *post hoc* analysis of the prospective multicenter data from France and Belgium: A Groupe de Recherche Respiratoire en Réanimation Onco-Hématologique [A Research Group on Acute Respiratory Failure in Onco-Hematological Patients (French)] Study, to identify determinants of 1-year survival in critically ill AL patients. A total of 278 patients were admitted in the 17 participating ICUs. Median age was 58 years and 70% had newly diagnosed leukemia. ICU mortality rate was 28.6 and 39.6% of the patients alive at 1 year. Admission for intensive monitoring was independently associated with better 1-year survival by multivariate analysis. Conversely, relapsed/refractory disease, secondary leukemia, mechanical ventilation and renal replacement therapy were independently associated with 1-year mortality. This study confirms the impact of organ dysfunction on long-term survival in ICU patients with AL. Follow-up studies to assess respiratory and renal recovery are warranted.

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Acute myeloid leukemia; acute lymphoblastic leukemia; intensive care; prognosis

Introduction

The short-term outcome of patients with acute leukemia (AL) has been extensively studied. Lower fibrinogen levels, comorbidity index and sepsis are known risk factors for clinical deterioration leading to intensive care unit (ICU) admission in patients with AL [1,2]. More than 60% of the patients with acute myeloid leukemia who require intensive care survive to ICU or hospital discharge [3–5]. Several predictive factors have been suggested: mechanical ventilation, poor performance status, comorbidity index, allogeneic hematopoietic stem cell transplant (HSCT), organ dysfunction score, cardiac arrest, acute respiratory failure, malignant organ infiltration and invasive aspergillosis were associated with higher mortality [3,6–8].

However, data concerning the long-term survival of critically ill AL patients after ICU discharge is still scarce [4,5,8] and larger population and multicenter studies are needed to evaluate outcomes and predictors. Firstly, there is an urgent need of multicenter outcome studies on patients with AL who require ICU admission. The main data are limited to small, retrospective, single-center studies with a mixed cohort of critically ill patients with all forms of hematological malignancies. Secondly, the impact of the characteristics of the underlying malignancy versus acute illness factors on the long-term survival needs to be clarified. Even though earlier studies showed that long-term survival was mainly predicted by hematologic prognostic factors [5,9], more recent studies suggest that factors related to the acute illness may be the strongest predictors [6,7]. Thirdly, the impact of early ICU admission on the long-term outcome remains unclear. Even though earlier studies on hematological patients did not show an impact on ICU mortality [10,11], a better survival for patients admitted more rapidly to the ICU was shown more recently [3]. The identification of prognostic factors of long-term survival can provide useful information for hematologists and intensivists

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that can facilitate discussions of prognosis with patients and families.

The aims of this study were to describe the long-term outcome of patients with AL admitted to critical care and investigate predictive factors of outcome using a secondary analysis based on a prospective multicenter cohort study of patients with hematological malignancies admitted to the ICU.

Methods

Patients and study design

The Prospective Multicenter Data from France and Belgium: A Groupe de Recherche Respiratoire en Réanimation Onco-Hématologique (A Research Group on Acute Respiratory Failure in Onco-Hematological Patients) Study was a prospective, multicenter study that recruited 1011 patients with hematological malignancies admitted to critical care in France and Belgium at 17 tertiary centers from January 2010 to May 2011 in a period of 16 months. The details of the study have been previously reported [3]. This study was primarily designed to evaluate prognostic factors of hospital discharge as well as maintenance of cancer chemotherapy, disease control and quality of life after ICU discharge. For the present study, only those 351 patients with AL were considered eligible. Inclusion criteria were a diagnosis of either AML (acute myeloid leukemia) or ALL (acute lymphoblastic leukemia) as defined by the World Health Organization. This included: 1) patients who were newly diagnosed having not yet received chemotherapy; 2) patients undergoing or having just received either remission induction or post-remission therapy; 3) patients with refractory or relapsing AL undergoing salvage treatment. HSCT recipients were excluded. A total sample of 278 patients, corresponding to 27.5% of the original cohort, was analyzed (Figure 1).

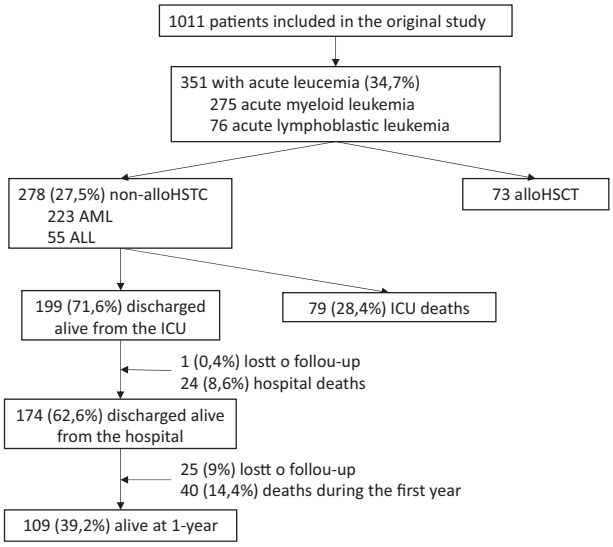

Figure 1. Patients included in the original Groupe de Recherche Respiratoire Réanimation Onco-Hematologique [A Research Group on Acute Respiratory Failure in Onco-Hematological Patients (French)] Study and subpopulation included in the present secondary analysis. alloHSCT: allogeneic hematopoietic stem cell transplant; ICU: intensive care unit.

Data collection and definitions

The database included data collected prospectively and daily by study investigators from admission to day 28: age, gender, comorbidities according to the Charlson score, performance status, type of malignancy, disease status, bone marrow transplant status, neutropenia, reason for admission, severity of illness [according to (Sequential Organ Failure Assessment) SOFA score], type of organ support (mechanical ventilation, noninvasive ventilation, renal replacement therapy and vasopressors) and microbiology. Vital status at one year was examined using both medical records and telephone interviews by a trained social worker. Newly diagnosed malignancies were defined as diagnosed within the past four weeks. Secondary leukemia included patients with prior exposure to cytotoxic therapy and/or radiotherapy for a malignant or non-malignant disease and patients that developed AL after a myelodysplastic syndrome or myeloproliferative neoplasm. Cytogenetic and molecular genetic risk were classified according to European LeukemiaNet (ELN) guidelines 2010 [12]. Admission for intensive monitoring was considered for patients with either high-risk lysis syndrome (hyperleukocytosis leukemia), bleeding or arrhythmia or rapid deterioration based on detected abnormalities in vital signs. Neutropenia and hyperleukocytosis were defined as leukocyte cell count $<0.5x10^9$/L and $\geq 50x10^9$/L, respectively.

Statistical analysis

Frequencies and measures of central tendency (median and interquartile range (IQR)) were used to describe categorical and continuous variables, respectively. Univariate logistic regression analyses were performed to identify hematologic and ICU-related factors that might predict ICU and 1-year mortality. Factors that were considered significant in the univariate analyses were selected for a multivariate binary logistic regression with stepwise backward selection. Cumulative survival estimates, Kaplan-Meier curves and hazard ratio point estimates for those patients

who survived ICU stay were performed. A two-tailed p value $\leq .05$ was considered statistically significant. All statistical analyses were performed using statistical software SPSS® 24.0 for Windows.

Results

Patient characteristics

Our final cohort included 278 adult patients diagnosed with AL that were admitted to critical care. Their median age was 58 years (IQR 44–66.2 years) and there were 160 (57.6%) male patients. Most patients had a good performance status ($\leq$2). Eighty percent had a diagnosis of AML and the remaining 20% had a diagnosis of ALL with the majority presenting with newly diagnosed leukemia. Fifty-seven patients had a secondary leukemia. Data on cytogenetic abnormalities were available in a subset of 117 patients with AML, of which 53, 32 and 32 were stratified, respectively, as an intermediate, low and high-risk leukemia. Details of demographic and clinical features of the 278 patients are shown in Table 1. Fifty-two patients (18.4%) were admitted to the ICU directly from the emergency department. The remaining 226 patients were admitted from the hospital ward with a median time interval between hospital and ICU admission of 12 days (2–24). The primary indication for ICU admission was severe sepsis/septic shock (37.8%) followed by intensive monitoring (23.4%). Half of the patients had dysfunction in multiple organ systems at the time of admission and only 34 patients (12.2%) did not present any organ dysfunction. Neutropenia was documented in 115 patients. During the ICU stay, 46.8, 45.7 and 26.6%, respectively, of the patients required, mechanical ventilation, vasoactive drugs and renal replacement therapy. No life-supporting intervention was required in 74 patients (26.7%). The median ICU length of stay (LOS) was five days (3–11) and the median hospital LOS was 20 days (9.5–34.5).

Outcomes

A total of 103 patients died during hospitalization, of which 79 (28.4%) died in the ICU and the remaining 24 (8.6%) died in the ward (Figure 1). Among the 174 patients discharged alive from the hospital, 109 were alive at 1-year corresponding to 39.2% of the cohort. The ICU-mortality of AML and ALL patients was 31.8 and 14.5%, respectively. The 1-year mortality of AML and ALL patients was 54.7 (12 missing) and 38.1% (14 missing), respectively. After excluding the 65 patients admitted for intensive monitoring, ICU mortality rate was 31% and 1-year survival rate was 34.7%.

Table 1. Patient demographics and clinical characteristics.

	Number of patients (% or IQR)
Age, years	
Median, IQR	58 (44–66.2)
>60 years	123 (44.2)
Male gender	160 (57.6)
Leukemia type	
Acute myeloid leukemia	223 (80.2)
M3 and M3v	24 (8.6)
M4 and M5	83 (29.8)
ELN 2010 risk classification	32 (11.5)
Favorable	53 (29)
Intermediate	32 (11.5)
Adverse	106 (37.8)
Unknown	55 (19.8)
Acute lymphoblastic leukemia	7 (2.5)
Philadelphia (+)	57 (20.5)
Secondary leukemia	
Disease status	
Newly diagnosed	197 (70.9)
Relapsed/Refractory	49 (17.6)
Remission	32 (11.5)
Comorbidities	
Hypertension	81 (29.1)
Diabetes	29 (10.4)
Ischemic heart disease	27 (9.7)
Hepatic	24 (8.6)
Renal	18 (6.5)
COPD	9 (3.2)
HIV/AIDS	4 (1.4)
Reasons for admission	
Severe sepsis/septic shock	105 (37.8)
Monitoring	65 (23.4)
Acute respiratory failure	57 (20.5)
Digestive	10 (3.6)
Coma	10 (3.6)
Cardiac arrest	10 (3.6)
Non-septic shock	6 (2.2)
Acute renal injury	5 (1.8)
Bleeding	4 (1.4)
Miscellaneous	6 (2.2)
Conditions of admission	
Time between hospital and ICU admission	
Median, days	6 (1–21.5)
<24h	61 (21.9)
Direct admission to the ICU	52 (18.7)
Neutropenia	68 (24.5)
Hyperleukocytosis	18 (16.5)
SOFA score, median	5 (3.8–8)
Charlson comorbidity index, median	4 (2–5)
Performance status $\leq$2	243 (83.8)
Organ failure	
Respiratory	166 (59.7)
Hemodynamic	106 (38.1)
Coagulation	75 (27)
Renal	72 (25.9)
Hepatic	20 (7.2)
Multiorgan	150 (54)
Outcomes	
ICU survival	199 (71.6)
Hospital survival	174 (62.6)
90-day survival	156 (56.1)
360-day survival	109 (39.2)
Treatments in the ICU	
Antibiotics	256 (92.1)
Ventilation	
Mechanical	130 (46.8)
Non-invasive	86 (30.9)
Renal replacement therapy	74 (26.6)
Amines	127 (45.7)
Infections identified in the ICU	
Bacterial	67 (24.1)
Gram positive	18 (6.5)
Gram negative	49 (17.6)
Fungal	25 (9)

COPD: chronic obstructive pulmonary disease; ELN: European Leukemia Net; HIV/AIDS: human immunodeficiency virus/acquired immunodeficiency syndrome; ICU: intensive care unit; IQR: interquartile range; SOFA: Sequential Organ Failure Assessment.

Comparing outcomes according to the status of the AL at admission, patients in remission showed a significantly better short and long-term survival (Table 2).

Prognostic factors

Mechanical ventilation and increasing SOFA were significantly associated with higher ICU mortality (Table 3). The most important predictive factors of 1-year mortality were disease status and secondary leukemia (Table 4). Patients with relapsed/refractory disease were almost four times more likely to have died 1-year after ICU admission than the other patients. Patients with secondary leukemia were 2.41 times more likely to have died 1-year after ICU admission. Age and the type of AL showed no association with the risk of

Table 2. Survival rates according to disease status at ICU admission.

	Newly diagnosed, $n = 197$	R/R, $n = 49$	Remission, $n = 32$[a]
ICU mortality	56 (28.4)	19 (38.8)	4 (12.5)[b]
1-Year mortality	99 (54.4)[c]	35 (83.3)[d]	9 (32.1)[e]

ICU: intensive care unit; R/R: relapsed/refractory.
[a]Complete remission ($n = 29$) and partial remission ($n = 3$).
[b]Remission vs. R/R, $p = .01$.
[c]Remission vs. Newly diagnosed, $p = .04$.
[d]R/R vs. Newly diagnosed, $p < .01$.
[e]Remission vs. R/R, $p < .01$.

Table 4. Univariate and multivariate predictors of 1-year mortality.

	1-year mortality					
	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*	OR	95% CI	*p*
Demographics						
Age	1.03	1.01–1.05	.000	1.01	0.99–1.04	.159
Leukemia factors						
Disease status						
Relapsed/refractory	4.22	2.01–11.11	.000	3.95	1.48–10.58	.01
Remission	0.32	0.14–0.74	.007	0.40	0.15–1.05	.63
Secondary leukemia	4.09	2.00–8.37	.000	2.41	1.09–5.32	.03
ALL versus AML	1.31	0.67–2.55	.436	–	–	–
Conditions of admission						
Multiorgan failure	1.61	0.97–2.66	.065	–	–	–
Charlson Index	1.32	1.15–1.52	.000	1.19	0.97–1.45	.90
Direct admission to ICU	1.25	0.66–2.38	.489	–	–	–-
SOFA	1.16	1.08–1.25	.000	1.04	0.95–1.49	.38
Sepsis	1.04	0.76–2.18	.317	–	–	–
Neutropenia	1.04	0.63–1.72	.887	–	–	–
Intensive monitoring	0.45	0.25–0.81	.008	0.46	0.21–1.00	.05
Treatments in the ICU						
Mechanical ventilation	3.43	2.03–5.80	.000	2.37	1.12–5.04	.03
Vasoactive drugs	3.05	1.81–5.15	.000	1.33	0.60–2.96	.48
RRT	2.44	1.34–4.47	.004	2.95	1.35–6.41	.01
Nosocomial infection	1.58	0.78–3.18	.201	–	–	–
Aspergillus	3.08	0.99–9.55	.052	–	–	–
Bacterial	0.95	0.37–2.45	.916	–	–	–
Candida	0.32	0.04–2.92	.314	–	–	–
ICU LOS	1.00	0.94–1.02	.830	–	–	–

ALL: acute lymphoblastic leukemia; AML: acute myeloid leukemia; ICU: intensive care unit; LOS: length of stay; RRT: renal replacement therapy; SOFA: Sequential Organ Failure Assessment; OR: odds ratio; 95% CI: 95% class interval.

Table 3. Univariate and multivariate predictors of ICU mortality.

	ICU mortality					
	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*	OR	95% CI	*p*
Demographics						
Age	1.02	1–1.03	.074			–
Leukemia factors						
Secondary leukemia	4.09	2–8.37	.000	2.26	0.95–5.34	.06
ALL versus AML	2.74	1.23–6.11	.013	2.18	0.80–5.97	.13
Disease status						
Relapsed/Refractory	1.78	0.94–3.40	.079	0.42	0.12–1.54	.19
Remission	0.33	0.11–0.96	.042		–	–
Leukocytosis	0.97	0.53–1.78	.920		–	–
Conditions of admission						
Multiorgan dysfunction	2.14	1.24–3.7	.006	0.87	0.40–1.86	.71
SOFA	1.28	1.18–1.38	.000	1.15	1.04–1.27	.01
Neutropenia	1.27	0.75–2.15	.370	–	–	–
Charlson Index	1.12	0.99–1.26	.072	–	–	–
Sepsis	0.81	0.47–1.39	.437	–	–	–
Direct admission to ICU	0.62	0.30–1.29	.201	–	–	–
Intensive monitoring	0.56	0.28–1.09	.088	–	–	–
Treatments in the ICU						
Mechanical ventilation	25.01	10.86–57.58	.000	12.63	4.77–33.42	<.01
Vasoactive drugs	9.21	9.87–17.41	.000	2.01	0.81–4.98	.13
RRT	3.46	1.96–6.12	.000	2.09	0.96–4.55	.06
Infection acquired in ICU	2.52	1.313–4.84	.005	0.62	0.27–1.44	.27
Bacterial	0.62	0.15–1.22	.166	–	–	–
Candida	2.58	0.51–13.06	.252	–	–	–
Aspergillus	2.43	0.95–6.23	.065	–	–	–
ICU LOS	1	1.00–1.02	.796	–	–	–

ALL: acute lymphoblastic leukemia; AML: acute myeloid leukemia; ICU: intensive care unit; LOS: length of stay; RRT: renal replacement therapy; SOFA: Sequential Organ Failure Assessment; OR: odds ratio; 95% CI: 95% class interval.

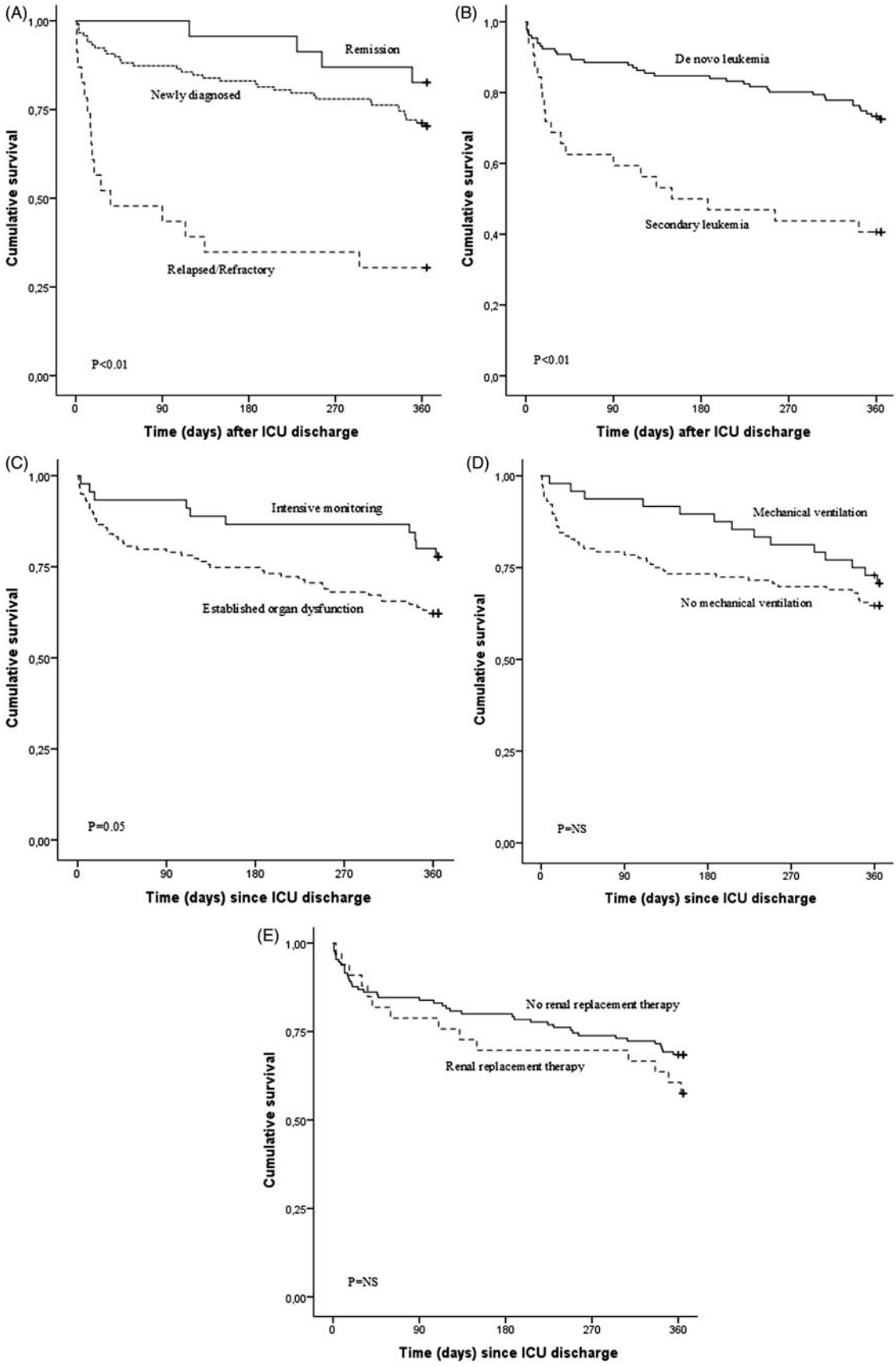

Figure 2. Cumulative survival according to independent predictive factors in 164 ICU survivors who could be evaluated: (A) disease status; (B) type of leukemia; (C) intensive monitoring; (D) mechanical ventilation and (E) renal replacement therapy.

1-year mortality. Patients admitted strictly for intensive monitoring were twice as likely to be alive at 1-year. Among ICU factors, mechanical ventilation and renal replacement therapy (RRT) were also associated with an increased risk of 1-year mortality.

Figure 2 displays 1-year cumulative survival among those patients who survived ICU stay according to independent predictive factors. Disease status and type of leukemia were major determinants of 1-year survival. Additionally, patients who were admitted for intensive monitoring also showed a lasting survival benefit. Mechanical ventilation did not show a statistically significant impact on the outcome. Post-ICU survival at 1-year in patients that received and not received RRT was nearly equivalent.

Discussion

In the past 20 years, there has been a shift in our thinking about ICU support in patients with AL. Early studies discouraged ICU admission based on the poor outcomes presented by those patients after ICU discharge. Following advances in life-sustaining therapies and close collaboration between hematologists and intensivists, recent studies have presented a more optimistic view of the impact of ICU admission and nowadays, unrestricted ICU support can be recommended for a large proportion of patients with all types of hematological malignancies. However, patients with AL admitted to ICU still exhibit significantly higher mortality rates when compared with patients who do not require intensive care [1,2,13]. Published studies have focused on short-term outcomes and multicentric studies describing the long-term survival of patients with AL are scarce. For this reason, we performed a *post hoc* analysis of patients with AL admitted to critical care. The main strengths of the present study are: (1) patients were treated over a time-span of 16 months in which the standard treatment was not substantially modified; (2) the study population was treated in 17 international centers; (3) data were collected prospectively in the original study and (4) robust statistical analyses were used to identify relevant variables related to the long-term outcome.

In our multicenter cohort of patients with AL admitted over a 16-month period to intensive care, 62.6% of the patients were discharged alive from the hospital and approximately two in three of them remained alive at 1-year. Our hospital mortality rate approximates that of the original cohort of 1011 patients with hematological malignancies (60.8%). Additionally, no significant impact on mortality rate of AML compared to ALL was observed. These results are in line with an increasing number of studies showing that the nature of the hematological malignancy does not influence the outcome [14–16]. Our ICU mortality and 1-year survival rates are similar to those reported form other western countries. An ICU mortality rate of 33.7% and a 1-year survival rate of 41.3% were reported from Australia, in a retrospective study that assessed the outcome of 505 patients with newly diagnosed AML admitted to two teaching hospitals during a 12-year period [8]. Retrospective single-center studies that included HSCT recipients (representing 12-13% of those cohorts) have revealed similar ICU mortality rates but lower 1-year survival rates, ranging from 25–33.7% [4,5]. Even though allogeneic HSCT patients may remain a subpopulation with a lower long-term survival, the outcome of those patients who require ICU level has improved considerably. In opposition to the overall western standard, ICU mortality rates remain very high in Asian countries, with the highest mortality rate shown in Korea (84.1%) [17].

Not surprisingly, our ICU mortality was mainly predicted by severity scores and the need for mechanical ventilation and RRT. Indeed, mechanical ventilation was the main determinant of ICU survival with an odds ratio (OR) for mortality of 12.63 (95% CI(95% class interval) 4.77–33.42). Among those patients surviving ICU, subjects who needed mechanical ventilation or received RRT no longer manifested an increased risk of death. The observed decrease in survival may attenuate after ICU discharge, but this finding needs further investigation. The SOFA scoring system was identified as a useful measure of the patient severity of acute illness corroborating data suggesting that it is the most adequate in patients with hematological malignancies [18]. Of most importance, admission of patients for intensive monitoring was associated with a significantly better long-term survival. Disease, patient, organizational and technical-related factors may have contributed to this effect. There is growing evidence that early intervention is particularly important for short-term outcomes of hematological patients. Identification of deteriorating patients in the ward and rapid response by an expert team leads to a decrease in the number of organ failures at ICU admission [10,11]. The median SOFA score of our cohort was inferior to other groups [4,8]. Our group showed previously that onco-hematological patients admitted earlier to the ICU benefit from a significantly decreased ICU mortality [3]. The results of our study suggest that the favorable impact of early intervention is perpetuated into the first year after ICU

admission, corroborating growing evidence of the lasting impact of ICU or hospital factors on the survival of onco-hematological patients admitted to intensive care [6,7,19].

Disease status is a classical AL prognostic factor and was the main determinant of 1-year mortality. Other studies have reported similar findings [4–7], even though the proportion of patients with relapsed/refractory disease in our study (17.4%) was lower compared to most of them. Both the short and the long-term mortality are lower for patients in remission and are higher for those with refractory/relapsed disease. Although the prognosis of adult patients with AL who relapse is poor, approximately 10% of patients with ALL [20] and 20–30% of patients with AML [21,22] may become long-term survivals. Additionally, it has been shown that AML patients who achieve complete remission only after a second cycle of induction have the same long-term outcome as patients with complete blast clearance after the first cycle of induction [23]. Thus, patients should not be denied admission to the ICU based exclusively on the presence of relapsed/refractory disease because carefully selected patients (patients undergoing reinduction for nonresponse and patients with a related/unrelated matched donor available) may benefit from intensive care. This requires an interdisciplinary approach that includes hematologists, intensivists, the patient and his/her relatives. Among the 49 patients with relapsed/refractory disease, 30 (61.2%) were discharged alive from the ICU and 23.3% of them (seven patients) were still alive at 1-year. Secondary leukemia is a broad term that includes patients with prior exposure to cytotoxic therapy and/or radiotherapy for a malignant or nonmalignant disease and patients that develop AL after a myelodysplastic syndrome or myeloproliferative neoplasm [24]. It is more extensively characterized in AML representing up to 25% of newly diagnosed cases compared to approximately 2% of newly diagnosed ALL [25]. Patients with secondary leukemia did significantly worse compared to *de novo* AL. Even though secondary leukemia is associated with factors that confer a poor prognosis such as older age, high-risk cytogenetics and poor response to standard chemotherapy [24–26], our study suggests that, in patients admitted to the ICU, it has a striking and independent effect on survival.

Age was not an independent predictor of long-term mortality suggesting that patients with AL may benefit from critical care independent of their age. A recent retrospective study focusing on the outcomes of older ($\geq$60 years old) AML patients following an ICU admission showed that a substantial proportional of these patients are admitted to the ICU and benefit from critical care, in particular those who lack multi-organ dysfunction [27]. Cytogenetics is an important factor whose prognostic impact remains unclear to the critical care provider. The karyotype of the leukemia cells is the strongest predictor factor across the landscape of AML treatment. Cytogenetics affects response to induction, relapse rates, success after transplant and overall survival [28–31]. Even though earlier studies on patients with AML admitted to intensive care identified AML cytogenetic risk groups as an independent predictor of survival after ICU discharge [8,32], recent studies, following recent risk stratification models, found no significant association between survival and cytogenetics [1,6,19]. Prospective studies are needed to clarify the association of molecular genetics and long-term survival in hematological patients admitted to the ICU.

Our study has several limitations. Firstly, a mixed population of patients with AML or ALL was included. The prognosis and treatment for those two malignancies were different and there were no details on the type of chemotherapy. However, we included mostly patients with newly diagnosed leukemia before treatment. Secondly, we could not evaluate well-known prognostic factors such as molecular genetics which could be of importance for prognostication of AML according to recently published ELN 2017 guidelines [33]. Furthermore, our collection of data was limited to information available in the database and though efforts were made to obtain complete information, data were missing for some patients. Finally, the generalizability of our results may be limited by a possible bias concerning hospital and ICU organizational factors which influence significantly the outcome of critically ill hematological patients [34,35]. The tertiary nature of the participating centers, the presence of a full-time intensivist and hematologist, a nurse-to-bed ratio of 1:2.5 and case-volume may have skewed the results towards a more positive outcome.

In summary, this *post hoc* analysis of patients with AL admitted to intensive care showed an ICU mortality rate of 28.4% and a 1-year survival rate of 39.6%. The long-term outcome was mainly determined by the status of the AL. Even though the severity of acute illness and ICU or hospital variables mainly predicted the short-term outcome, these associations seem to last up to 1-year. Our results primarily confirm previous publications and reinforce the importance of formal and informal exchanges between hematologists and intensivists to delineate the optimal treatment strategy of critically ill AL patients.

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