Epidemiology, management, and economic impact of acute myeloid leukemia and myelodysplastic syndrome in Spain at the hospital level: a claims database analysis

Alicia Marsà,[1] Meritxell Ascanio,[1] Javier Diaz-García,[2] Josep Darbà[3]

[1]Department of Health Economics, BCN Health Economics & Outcomes Research SL, Barcelona, Spain; [2]Medical Department, Jazz Pharmaceuticals Iberia, Barcelona, Spain; [3]Department of Economics, Universitat de Barcelona, Barcelona, Spain.

Corresponding author:

Alicia Marsà, PhD

BCN Health Economics & Outcomes Research SL

Travessera de Gracia 62, 5-6

08006 Barcelona, Spain

Phone: +34 932091865

Email: alicia.marsa@bcnhealth.com

ORCID number for Alicia Marsà: 0000-0001-8116-7029

ORCID number for Josep Darbà: 0000-0003-2371-0999

Abstract word count: 250 words

Word count: 5168 words

Number of tables/figures: 4 tables and 3 figures

Abstract

Objective: This study reviewed patient characteristics, management, and medical costs of acute myeloid leukemia (AML) and myelodysplastic syndromes (MDS) in Spanish hospitals.

Methods: Data were extracted from the Spanish Ministry of Health records via a claims database containing patient records from 192 private and 313 public hospitals between 1997-2015 for AML, and 2008-2015 for MDS. Direct medical costs at the hospital level were calculated based on mean medical procedure costs determined per the Spanish Ministry of Health.

Results: Records for 39,568 patients with AML and 33,091 with MDS were analyzed. The median age of AML patients was 65 years (interquartile range [IQR]=27) and of MDS patients was 81 years (IQR=12). In terms of disease management, 58% and 83% of admissions were due to emergencies for patients with AML and MDS, respectively; median length of hospital stay was 14 days (IQR=25) for AML and 7 days (IQR=9) for MDS. There was an increase in allogeneic hematopoietic stem cell transplantations over time for patients with AML or MDS. Mean annual direct medical costs of AML and MDS, respectively, were €66,422,245 and €42,635,313 for total costs, and €30,775 and €10,312 per patient. Of the total costs, transplantations contributed total annual costs of €15,843,982 and €2,705,791 for patients with AML and MDS, respectively.

Conclusions: This study provides novel data to assist decision makers in allocating resources. AML and MDS represent a significant burden for the National Spanish Healthcare System, with substantial costs incurred in secondary care, principally associated with the increasing number of transplantations.

Keywords: acute myeloid leukemia, epidemiology, health resources, hospital costs, medical care costs, myelodysplastic syndrome

Short title: Impact of AML and MDS in Spain

Introduction

The term ‘acute myeloid leukemia’ (AML) refers to a group of malignancies in which the bone marrow, blood, and other tissue are infiltrated by abnormal, proliferative myeloid precursors. Often, AML appears as a secondary disease after chemotherapy for another cancer (therapy-related AML) or progressed from antecedent syndromes such as myelodysplastic syndrome (MDS) [1]. It is estimated that MDS will progress into AML in about 30% of cases [2]. MDS, in turn, consists of a heterogeneous group of clonal hematopoietic stem cell disorders with a wide range of clinical presentations, mutation patterns, and outcomes, always characterized by low blood cell counts and abnormal blood cell development [3].

The study of both pathologies has been of key importance given their increasing prevalence and elevated mortality. A previous study of data from the European Cancer Registry–based Study on Survival and Care of Cancer Patients (EUROCARE-4), which includes Spanish data, established an incidence of AML and related precursor neoplasms of 3.7 per 100,000 persons per year between 1995 and 2002 [4]. Similarly, the incidence rate of AML in both the United Kingdom and United States is between 4 and 5 cases per 100,000 persons per year, while its mortality rate is between 3 and 4 cases per 100,000 persons per year [5, 6]. For MDS, the incidence rate has been estimated at around 4.6 cases per 100,000 persons per year in the United States [6], while in Europe estimates are at 3.8 cases per 100,000 persons per year [7]. The mortality rate of MDS is between 2.2 and 5.5 cases per 100,000 persons in 2011 [8]. Despite the increasing number of studies analyzing the molecular basis and recent advances of both diseases, published information on patient characteristics and disease management is still not available for Spain.

The lack of accurate epidemiology studies on both AML and MDS in Spain, as well as the absence of information available on their economic impact, motivated this study. Thus, this report reviews patient characteristics, resource use, and costs associated with the management of AML and MDS at the hospital level, using patient records, providing an accurate analysis of the current status of these diseases in Spain.

Materials and methods

Study setting

The present report evaluates information extracted from the Ministry of Health records via the Spanish claims database Minimum Basic Data Set (Conjunto Mínimo Básico de Datos) [9], which contains all patient records compiled from 192 private hospitals and 313 public hospitals covering all regions in Spain. Available AML records include data from 1997 to 2015, whereas records on MDS include data from 2008 to 2015. Parameters such as health centers and medical history identifiers were re-coded at the health care center level in order to maintain anonymized records in accordance with the principles of Good Clinical Practice and the Declaration of Helsinki.

Data extraction

Admission records in which AML and MDS were registered were petitioned and identified using the International Statistical Classification of Diseases and Related Health Problems version 9 (ICD-9) codes: 205.00, 205.01, 205.02, 238.72, 238.73, 238.74, and 238.75. Both inpatient admissions and outpatient hospital visits were obtained, always defined as an "admission" and distinguishable by length of stay.

Study variables

The following variables were extracted from the database: patients' sex and age, date of admission, date of discharge, type of admission, type of discharge (including death), hospital service, readmission rate (understood as a subsequent admission for the same cause within 30 days after discharge), admission motive, up to 20 secondary diagnoses registered during the admission, and the imputed admission cost.

Data analysis

The extraction of single-patient information was carried out to characterize the patient population by eliminating repeated records that corresponded to separate admissions, relying on the first admission as the index event. This first admission was analyzed to obtain single-patient evidence of patient characteristics (sex and age) and financial scheme. All admission files were used to evaluate information on hospital admission and discharge, length of stay, hospital services, medical procedures performed, and costs. Secondary conditions diagnosed during the admission, including disease comorbidities and disease complications, were also studied. Independent analyses were performed for patients younger than 70 years and those aged 70 and older separately, as well as patients with acute promyelocytic leukemia (APL).

Direct medical costs of hospital care were calculated based on the costs per admission registered in the database, which are imputed according to the unit costs of medical procedures determined by the Spanish Ministry of Health (these include all expenses related to the admission: examination, medication, surgery, diet, costs associated with

personnel, medical equipment, and resources) [10]. This allowed calculation of the average costs per patient and per hospital admission, as well as the annual cost of the disease and the evolution of direct medical costs for each disease over time. All in-hospital expenses were included, as well as any medication received during the admission (inpatient and outpatient). The costs of transplantations and chemotherapy administrations were also evaluated. To determine the annual direct economic impact of these diseases at the hospital level, the analysis included data from 1999 to 2015 for AML and from 2008 to 2015 for MDS; data from 1997 and 1998 were excluded to obtain a more consistent analysis due to the detection of errors that likely resulted from the introduction of the Euro in Spain.

The data presentation is mainly descriptive. Statistical analyses were performed using Microsoft® Excel Professional Plus 2010 (Microsoft Corporation, Redmond, WA, USA).

Results

Patient characteristics

The total number of hospital admissions analyzed was 102,783 for AML and 64,556 for MDS, while the total number of individual patients was 39,568 and 33,091 for each disease, respectively (**Table 1**); 11.92% of all patients with AML presented with APL.

Analyses on patients' sex and age did not show relevant differences for AML or MDS. Female patients with AML represented 44.67% of the total, while male patients represented 55.31%; for MDS, female patients represented 44.16% and male patients 44.84% of the total, while the rest were unspecified. Patients' median age was almost equal for both sexes: the median age of patients with AML was 65 years (interquartile range [IQR]=27) for

males and 64 years (IQR=30) for females, whereas median age of patients with MDS was 80 years (IQR=39) for males and 80 years (IQR=12) for females. Age distribution for all patients peaked at ages 70 to 79 years for AML and ages 80 to 89 years for MDS (**Figure 1A¡Error! No se encuentra el origen de la referencia.**).

Up to 20 secondary conditions registered during the admission were evaluated for all patient records. In the case of AML, 62.16% of patients had different types of anemia, 46.82% had a diagnosis of hypertension, and 24.90% were affected by type 2 diabetes mellitus; patients over 70 years of age presented with higher frequencies of several conditions, primarily essential hypertension and type 2 diabetes. Conditions registered in more than 10% of patients with AML are listed in **Table 1**. Patients with APL displayed similar frequencies, but were diagnosed with neutropenia in 30.39% of admissions. In patients with MDS, anemia was also the most common secondary condition, diagnosed in 33.09% of patients; 32.76% were hypertensive and 24.76% had type 2 diabetes mellitus (**Table 1**). A similar trend was observed in the diagnosis of secondary conditions by age.

The percentage of patients who died during hospitalization (in-hospital mortality) was also compiled (16.23% for AML and 12.89% for MDS) and was stable over the study period (**Figure 1B**). In patients with AML, the in-hospital mortality rate was 21.77% for urgent admissions and 8.52% for scheduled admissions; in MDS, these rates were 14.09% and 6.85%, respectively (**Table 1**).

Disease management

A total of 102,783 admissions were analyzed for AML, and 64,556 admissions were analyzed for MDS. Less than 1% of the files corresponded to outpatient hospital visits. In both cases, the portion of admissions through the emergency room increased greatly with patients' age: up to 77.60% in patients aged 70 years and older with AML (**Table 2**) and up to 86.86% in patients aged 70 years and older with MDS (**Table 3**). The most common services to attend patients are shown in **Figure 2A**. For both diseases, most admissions were registered into hematology and internal medicine services.

Length of hospital stay and patients' condition at discharge were analyzed. Median length of hospital stay was 14 days (IQR=25) for AML and 7 days (IQR=9) for MDS (**Table 2**); 11.09% of AML admissions and 2.94% of MDS admissions exceeded 30 days of hospital stay. Patient destination after discharge was also determined based on the same records; in most cases, this was the patient's residence. The database also provided the number of patients readmitted in the 30 days following discharge, likely related to the administration of a new chemotherapy cycle. Readmissions took place in 41.97% of the AML cases and 22.87% of the MDS cases.

Procedures performed on more than 10% of admissions are listed in **Table 2** and **Table 3**. The database also allowed for the calculation of total admissions due to chemotherapy administration and the infusion of antineoplastic agents: 52.50% of patients with AML received chemotherapy or immunotherapy, with a mean of 2.5 admissions per patient related to the administration of chemotherapy or immunotherapy; 6.11% of patients with MDS received chemotherapy, with a mean of 1.7 related admissions per patient. The specific treatment received by patients with APL was only reflected as an increase in the

administration of chemotherapeutic substances (60.36%). For both AML and MDS, the percentage of patients receiving chemotherapy was higher in those younger than 70 years of age and was considerably reduced in older patients.

Separately, the number and nature of transplantations were examined. The number and type of transplantations in patients admitted with AML and MDS are listed in **Table 2** and **Table 3,** respectively. Throughout the study period, 14.35% and 1.85% of patients with AML and MDS, respectively, received transplantations; the median age of patients receiving a transplantation was 45 years (IQR=25) for AML and 54 years (IQR=16) for MDS. In patients with AML, 2,410 autologous and 3,830 allogeneic transplantations were performed, while 24 autologous and 640 allogeneic transplantations were performed in patients with MDS. The total number of allogeneic hematopoietic stem cell transplantations increased over the years for both diseases (**Figure 2B**). In addition, as observed for the infusion of chemotherapy, the majority of the registered transplantations were performed in patients under 70 years of age.

Use of health care resources

The mean annual direct medical cost of secondary care was €66,422,245 for AML and €42,635,313 for MDS. The direct medical cost of AML increased 3.7-fold from 1999 to 2011, a period that was not analyzable for MDS (**Figure 3A**). A similar pattern was observed in the evolution of costs per patient (**Figure 3B**). For AML, the mean annual costs were €30,775 per patient and €11,756 per hospital admission; the mean cost per admission in patients with APL was €9,704 (**Table 4**). Bone marrow and hematopoietic stem cell transplantations in these patients were associated with an annual cost of €15,843,982, while

the administration of chemotherapy totaled €7,604,858 (excluding pharmaceutical costs), approximately €6590 per patient. For MDS, the mean annual costs were €10,312 per patient and €5284 per hospital admission. Bone marrow and hematopoietic stem cell transplantations in patients with MDS were associated with an annual cost of €2,705,791, while the administration of chemotherapy totaled €1,159,804, approximately €4589 per patient. Total costs and costs per patient for both AML and MDS were higher in patients under 70 years of age.

Data obtained on the financing scheme of patients showed a majority of patients using Social Security financing in both cases: 96.07% of patients with AML and 97.14% of patients with MDS. Patients using mutual or private financing was less than 3% among patients with AML and MDS.

Discussion

The epidemiology of AML has been previously revised in several European countries and other regions, including Canada, Australia, and Brazil, contributing data on disease incidence and survival rates [4, 11, 12, 13]. Additionally, an analysis of AML epidemiology was recently presented for Spain, providing an interesting revision of the current disease state from a physician's point of view [14]; unfortunately, patient data were not included in the analysis, leaving an important gap in the literature. Similarly, the characteristics and use of health care resources for patients with MDS have not been previously explored in Spain. Herein, novel data were generated through the retrospective analysis of patient hospital records, providing an important view on the status of AML and MDS at the hospital level in Spain.

This study identified 39,568 patients with a diagnosis of AML between the years 1997 and 2015, and 33,091 patients with a diagnosis of MDS between the years 2008 and 2015, registered at the hospital level. Consistent with data from Cancer Research UK, the sex bias in patients with AML is more pronounced as the age of diagnosis increases, with a male to female ratio of 1.9:1 at ages 80 to 84 years [4]. Comparable retrospective studies in other regions have revealed higher incidence rates of both malignancies among males [15, 16], and our study supports a higher proportion of male versus female patients diagnosed with AML, although no difference was observed for MDS. Similarly, it has previously been established that incidence rates increase with age. The age groups with the highest number of diagnoses (i.e., 70-79 years for AML and 80-89 years for MDS) in our study were consistent with prior reports for other European countries and the United States [4, 12, 16].

Secondary conditions identified in this study provide a general view of patients' health circumstances, although the frequencies described herein cannot be extrapolated to the entire patient population. The large number of patients with AML and MDS presenting with hypertension (46.82% and 32.76%, respectively) is plausible given the frequency of cardiac injury among these patients, which results in an increased mortality. This association has been linked to an effect derived from the chemotherapy treatment, as well as with the prevalence of anemia in patients with MDS [17, 18]. Acute leukemia has also been associated with an increased frequency of hyperglycemia, mostly in correlation with treatment [19]. A link with diabetes has also been described for MDS, with a more prominent connection found in Spain [20].

To further investigate the management of AML and MDS in Spain, an analysis of hospital admissions and the most common procedures performed during hospitalization was considered of interest. Moreover, the evaluation of medical procedures is crucial for the subsequent economic study. The majority of hospital admissions originated through the emergency room, particularly for patients with MDS, and the predominance of urgent admissions provides information for understanding the disease management. Unexpectedly high patient readmission rates were revealed by hospitalization data, often related to readmissions for the administration of a new chemotherapy cycle within 30 days. Regarding hospitalization procedures, hematology remains the service to admit most of these patients. It is also interesting to highlight the increasing number of allogeneic hematopoietic stem cell transplantations in this study, which is consistent with the independent reports on transplantations in Spain [21].

It was not the objective of the study to determine disease mortality, although patient records included information on patients who died during hospitalization (in-hospital mortality; 16.23% for AML and 12.89% for MDS).

Comparability of the annual total cost of each disease with data in other countries is limited given the distinct cost factors that must be considered, as well as variations in demographics and costs of each service. In addition, few studies have reported the use of health care resources for AML and MDS. In our study, the annual direct medical cost of secondary care of AML was €66,422,245, whereas the annual direct medical cost of MDS totaled €42,635,313. Despite their limitations, registries indicate direct medical costs in AML constitute 66% to 92% of the total costs, with transplantations contributing a large

portion of these costs [22]. Prior research estimated the mean total medical costs of AML as high as US$386,077 (approximately €355,600) per patient in the United States (including treatment costs) [23]. The annual direct medical costs of MDS in the United States were estimated at €62,540 per patient, while in Germany they were €14,883 per patient [24, 25]. Costs were lower in this study, but it must be considered that only hospital care was analyzed. In this study, the average annual cost per patient with AML was €30,775, with an average cost per hospital admission of €11,756, while these costs in patients with MDS were €10,312 and €5284, respectively. Direct medical costs declined after the year 2012, which could be associated with the effects of the global economic crisis in Spain and the subsequent reduction of the healthcare budget, as it is reflected in the statistical reports published by the Spanish Ministry of Health [26].

This study was limited by a series of factors. First, only the patients receiving hospital treatment could be evaluated, which impeded an accurate evaluation of disease incidence; this same factor must be taken into account when reviewing patients' characteristics and mortality. In these terms, the portion of patients presenting with AML after being registered with MDS was not evaluated. Secondly, patient data were obtained for the selected time period, and it was not possible to analyze patients' treatment and transplantation status before the study period. Finally, hospital costs were measured for both diseases, and further studies will thus be required to estimate the total burden of these diseases, taking into account out-of-hospital medical care, prescription medication costs, and non-medical costs.

Conclusions

Overall, 39,568 individuals were registered with AML in Spanish hospitals between 1997 and 2015, and 33,091 were registered with MDS between 2008 and 2015, with higher incidence rates of both malignancies observed among older patients. The mean age was 59.70 years in patients with AML and 78.34 years in those with MDS. In terms of disease management, most patients were admitted through the emergency room and into hematology services, and bone marrow and hematopoietic stem cell transplantations presented a remarkable increasing trend over time. The evaluation of direct medical costs of hospital care determined a mean annual cost per patient of €30,775 for AML and €10,312 for MDS.

This retrospective study exposes some of the most important patient characteristics and specific data relative to disease management, highlighting the potential of patient records–based analysis. Further evaluations of AML and MDS epidemiology will facilitate the identification of physician and patient needs, as well as center health care providers' priorities.

Transparency section

Declaration of funding: This work was supported by Jazz Pharmaceuticals.

Declaration of financial/other relationships: JDG is an employee of Jazz Pharmaceuticals Iberia. The other authors have no conflicts of interest to disclose.

Author contributions: MA was responsible for data extraction and analysis of patients' characteristics. AM analyzed the current situation and management of AML and MDS in Spain and was a major contributor in writing the manuscript. JDG provided overall analysis and interpretation of the data. JD contributed to the investigation by analyzing and

interpreting the burden associated with AML and MDS in Spain and was a major contributor to the intellectual content revision. All authors contributed to the development or critical revision of the manuscript and approved the final manuscript for publication.

Acknowledgments: We thank Teresa Briones of Jazz Pharmaceuticals Iberia for her contributions to the analysis of the data. Editorial assistance was provided by Kimberly Brooks, PhD, CMPP™, of SciFluent Communications, Inc., and was financially supported by Jazz Pharmaceuticals.

Data availability statement: All relevant data are provided within the manuscript and supporting files.

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Table 1. Characteristics of Patients With AML and MDS and In-hospital Mortality Rates

	Total	<70 years of age	≥70 years of age
Patients with AML, n	39,568	23,715	15,853
Secondary conditions registered upon admission, %			
Anemia	62.16	72.35	46.91
Unspecified essential hypertension	46.82	35.58	63.68
Type 2 diabetes mellitus	24.90	18.99	33.74
Bacteremia	19.09	27.66	9.18
Neutropenia	17.72	27.20	7.97
Acute respiratory failure	14.78	14.49	17.99
Unspecified hyperlipidemia	13.37	11.31	16.45
Acute and unspecified renal failure	13.32	13.21	13.49
Atrial fibrillation	11.17	5.55	19.93
Pneumonia	10.92	8.15	15.08
In-hospital mortality rate, %	16.23	10.89	29.10
Urgent admissions	21.77	14.80	32.58
Non-urgent/programmed admissions	8.52	6.98	16.93
Patients with MDS, n	33,091	5404	27,687
Secondary conditions registered upon admission, %			
Anemia	33.09	24.96	34.92
Unspecified essential hypertension	32.76	21.47	35.29
Type 2 diabetes mellitus	24.76	17.47	26.38
Atrial fibrillation	21.36	6.22	25.42
Cardiac valve disorder or insufficiency	12.92	4.44	14.75
Hypertensive chronic kidney disease	11.17	3.56	12.94
Unspecified hyperlipidemia	11.08	8.56	11.65
In-hospital mortality rate, %	12.89	8.69	34.24
Urgent admissions	14.09	10.09	14.74
Non-urgent/programmed admissions	6.85	5.04	7.82

AML, acute myeloid leukemia; MDS, myelodysplastic syndrome.

Table 2. Disease Management of Patients With AML

	Total (n=39,568)	**<70 years of age (n=23,715)**	**≥70 years of age (n=15,853)**
Origin of admission, %	-	-	-
Emergency room	58.07	49.96	77.60
Programmed	41.24	49.30	21.83
Other	0.70	0.75	0.57
Length of hospital stay, days, median (IQR)	14 (25)	21 (26)	9 (14)
Procedures performed in >10% of patients, %	-	-	-
Biopsy of bone marrow	23.76	25.30	20.07
Computed tomography of thorax	10.72	12.04	7.55
Diagnostic ultrasound of abdomen and retroperitoneum	11.19	11.67	10.01
Diagnostic ultrasound of heart	10.96	12.11	8.20
Electrocardiogram	4.74	3.48	7.78
Injection of antibiotic	20.52	20.74	19.96
Injection or infusion of cancer chemotherapeutic substance[a]	44.10	52.76	23.25
Injection or infusion of other therapeutic or prophylactic substance	7.83	7.14	9.51
Microscopic examination of blood/other microscopic examination	7.94	7.16	9.81
Routine chest x-ray	11.19	9.56	15.10
Transfusion of packed cells	42.09	39.04	49.41
Transfusion of platelets	30.75	33.00	25.35
Venous catheterization	12.68	15.14	6.76
Hematopoietic stem cell transplantations, n	6312	6244	68
Autologous	2410	2366	44
Bone marrow	352	347	5
Peripheral stem cell	2058	2019	39
Allogeneic	3830	3807	23
Bone marrow	764	759	5
Peripheral stem cell	2702	2684	18
Umbilical cord blood	364	364	0
Unspecified	72	71	1

AML, acute myeloid leukemia; IQR, interquartile range.

[a]Chemoembolization, injection, or infusion of antineoplastic agent or biological response modifier (defined as immunotherapy, antineoplastic infusion of cintredekin besudotox, interleukin therapy, low-dose interleukin-2 therapy, or tumor vaccine).

Table 3. Disease Management of Patients With MDS

	Total (n=33,091)	**<70 years of age (n=5404)**	**≥70 years of age (n=27,687)**
Origin of admission, %	-	-	-
Emergency room	83.35	66.69	86.86
Programmed	16.44	33.01	12.95
Other	0.20	0.29	0.19
Length of hospital stay, days, median (IQR)	7 (9)	8 (14)	7 (8)
Procedures performed in >10% of patients, %	-	-	-
Biopsy of bone marrow	7.67	15.20	6.08
Computed tomography of thorax	9.13	15.20	7.86
Diagnostic ultrasound of abdomen and retroperitoneum	12.34	14.77	11.83
Diagnostic ultrasound of heart	10.01	10.89	9.82
Electrocardiogram	15.46	7.41	17.16
Injection of antibiotic	19.11	20.88	18.74
Injection or infusion of cancer chemotherapeutic substance[a]	3.91	14.20	1.74
Injection or infusion of other therapeutic or prophylactic substance	11.28	9.93	11.56
Microscopic examination of blood/other microscopic examination	11.48	10.37	11.71
Routine chest x-ray	20.06	12.81	21.58
Transfusion of packed cells	40.83	38.92	41.23
Transfusion of platelets	9.32	19.35	7.21
Hematopoietic stem cell transplantations, n	666	664	2
Autologous	24	24	0
Bone marrow	2	2	0
Peripheral stem cell	22	22	0
Allogeneic	640	638	2
Bone marrow	97	96	1
Peripheral stem cell	508	507	1
Umbilical cord blood	35	35	0
Unspecified	2	2	0

MDS, myelodysplastic syndrome; IQR, interquartile range.

[a]Chemoembolization, injection, or infusion of antineoplastic agent or biological response modifier (defined as immunotherapy, antineoplastic infusion of cintredekin besudotox, interleukin therapy, low-dose interleukin-2 therapy, or tumor vaccine).

Table 4. Direct Medical Costs of AML and MDS: Total Costs and Expenses Relative to Transplantations and Chemotherapy Administration

	Total	**<70 years of age**	**≥70 years of age**
Patients with AML			
Total annual direct medical costs	€66,422,245	€49,547,488	€16,874,757
Per patient	€30,775	€38,285	€18,873
Annual costs of transplantations	€15,843,982	€15,694,795	€149,188
Autologous	€3,780,914	€3,711,792	€69,122
Allogeneic	€12,063,068	€11,983,003	€80,065
Annual costs of chemotherapy administration	€7,604,858	€6,438,295	€1,166,563
Per patient	€6590	€6,995	€4,811
Patients with MDS			
Total annual direct medical costs	€42,635,313	€11,161,536	€31,473,777
Per patient	€10,312	€16,523	€4,722
Annual costs of transplantations	€2,705,791	€2,694,816	€15,370
Autologous	€181,623	€181,623	€0
Allogeneic	€2,524,804	€2,513,193	€15,370
Annual costs of chemotherapy administration	€1,159,804	€697,310	€462,494
Per patient	€4589	€4,641	€4,463

AML, acute myeloid leukemia; MDS, myelodysplastic syndrome.

Figure captions

Figure 1. Age distribution of patients diagnosed with AML and MDS (A) and annual in-hospital mortality (B). AML, acute myeloid leukemia; MDS, myelodysplastic syndrome.

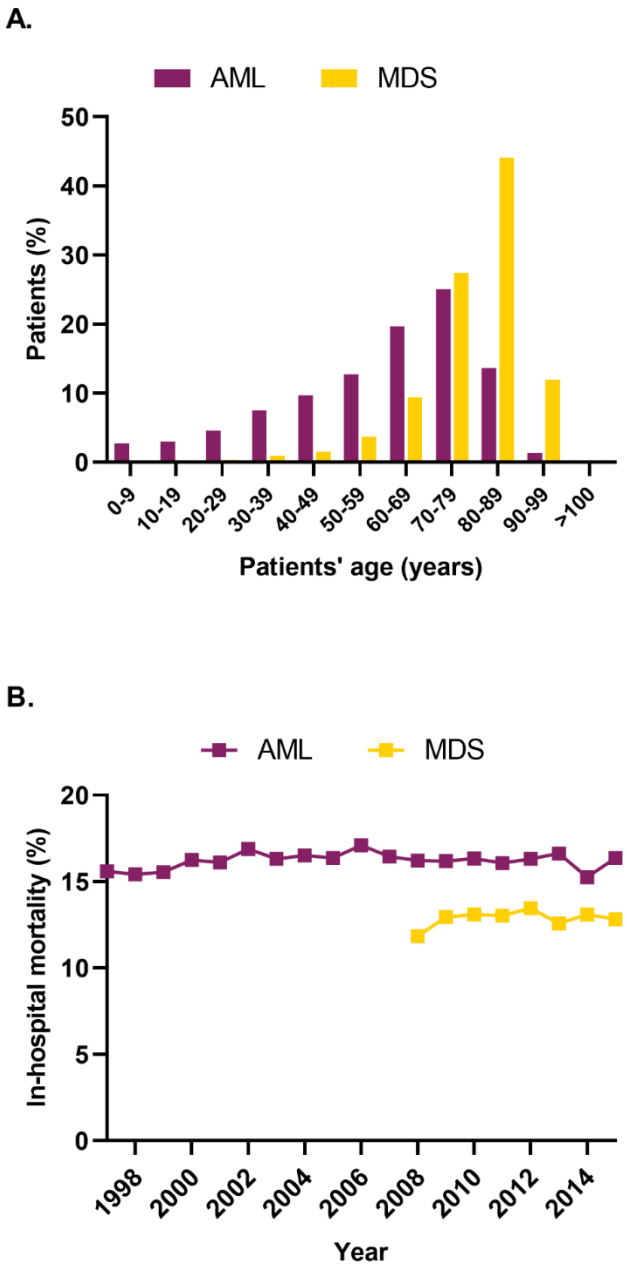

Figure 2. Services that attended patients with AML and MDS (A) and number of autologous and allogeneic hematopoietic stem cell transplantations over time (B). AML, acute myeloid leukemia; MDS, myelodysplastic syndrome.

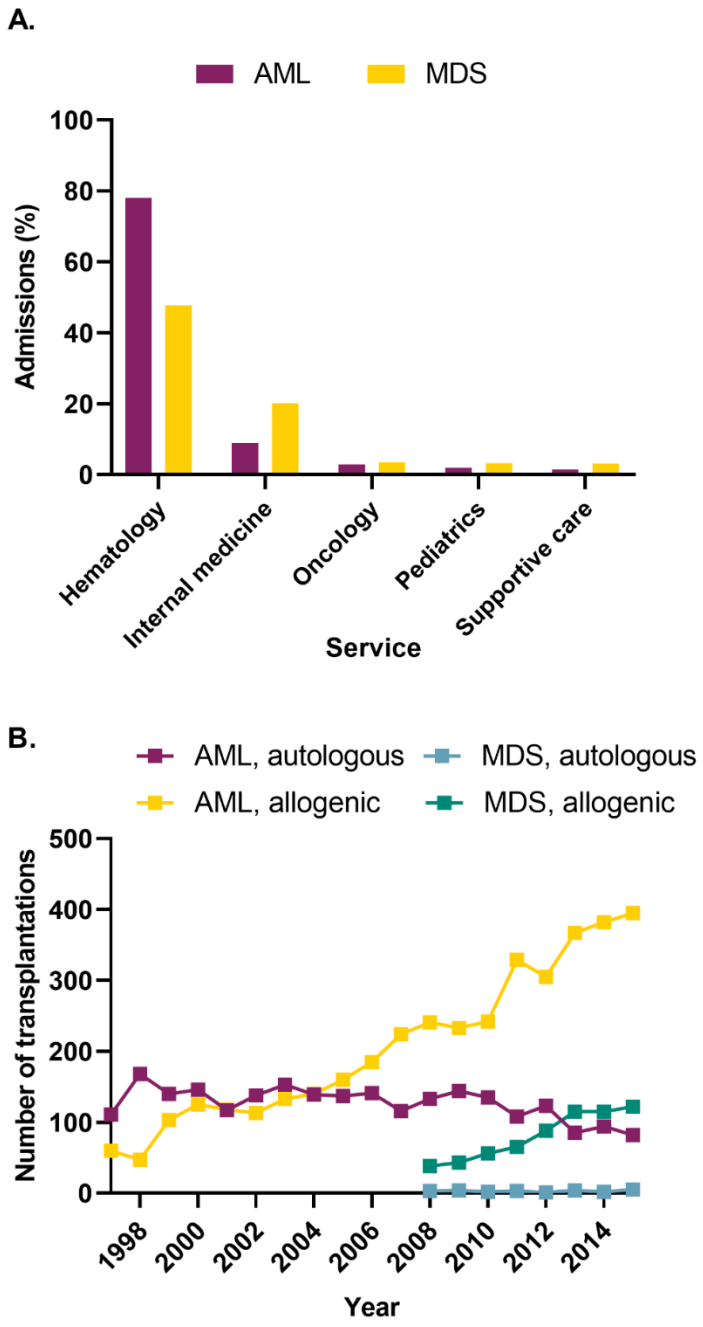

Figure 3. Total direct medical costs (A) and costs per patient (B) for AML and MDS over time. AML, acute myeloid leukemia; MDS, myelodysplastic syndrome.