Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Effect of age, comorbidity and remission status on outcome of COVID-19 in patients with hematological malignancies

Pronamee Borah a, Sumeet Mirgh b, Sanjeev Kumar Sharma c, Sachin Bansal d, Ashish Dixit e, Tuphan Kanti Dolai f, Sweta Lunkad g, Naveen Gupta h, Gurmeet Singh i, Aditi Jain j, Divya Bansal k, Dharm Choudhary v, Vipin Khandelwal c, Divya Doval i, Meet Kumar d, Rahul Bhargava d, Amrita Chakrabarti i, Mallikarjun Kalashetty e, Amit Rauthan e, Bilal Kazi f, Prakas Kumar Mandal f, Preethi Jeyaraman a, Rahul Naithani a, *, AIIMS Hematology Alumni Group

a Max Superspeciality Hospital, Saket, New Delhi, India
b Tata Memorial Centre, ACTREC, Mumbai, India
c BLK Superspeciality Hospital, New Delhi, India
d Fortis Memorial Hospital, Gurugram, India
e Manipal Hospital, Bengaluru, India
f NRS Medical College and Hospital, Kolkata, India
g Avinash Cancer Clinic, Pune, India
h Jawahar Lal Nehru Hospital & Research Centre, Bhilai, India
i Safdarjung Hospital, New Delhi, India
j Manipal Hospital, New Delhi, India

ARTICLE INFO

Editor: Mohandas Narla

Keywords: COVID-19 Hematology Remission Comorbidity Survival

ABSTRACT

Background: There is scarcity of data on outcome of COVID-19 in patients with hematological malignancies. Primary objective of study was to analyse the 14-day and 28-day mortality. Secondary objectives were to correlate age, comorbidities and remission status with outcome.

Methods: Retrospective multicentre observational study conducted in 11 centres across India. Total 130 patients with hematological malignancies and COVID-19 were enrolled.

Results: Fever and cough were commonest presentation. Eleven percent patients were incidentally detected. Median age of our cohort was 49.5 years. Most of our patients had a lymphoid malignancy (n = 91). One-half patients (52%) had mild infection, while moderate and severe infections contributed to one-fourth each. Sixty-seven patients (52%) needed oxygen for treatment of COVID-19 infection, half (n = 66) received antivirals. Median time to RT-PCR COVID-19 negativity was 17 days (7–49 days). Nearly three-fourth (n = 95) of our patients were on anticancer treatment at time of infection, of which nearly two-third (n = 59; 64%) had a delay in chemotherapy. Median time to RT-PCR COVID-19 negativity was 17 days (7–49 days). Nearly three-fourth (n = 95) of our patients were on anticancer treatment at time of infection, of which nearly two-third (n = 59; 64%) had a delay in chemotherapy. Overall, 20% (n = 26) patients succumbed. 14-day survival and 28-day survival for whole cohort was 85.4% and 80%, respectively. One patient succumbed outside the study period on day 39. Importantly, death rate at 1 month was 50% and 60% in relapse/refractory and severe disease cohorts, respectively. Elderly patients (age ≥ 60) (p = 0.009), and severe COVID-19 infection (p = 0.000) had a poor 14-day survival. The 28-day survival was significantly better for patients in remission (p = 0.04), non-severe infection (p = 0.00), and age < 60 years (p = 0.05).

Conclusions: Elderly patients with hematological malignancy and severe covid-19 have worst outcomes specially when disease is not in remission.

* Corresponding author at: Hematology & Bone Marrow Transplantation, Max Superspeciality Hospital, Delhi 110017, India.
E-mail address: dr_rahul6@hotmail.com (R. Naithani).

https://doi.org/10.1016/j.bcmd.2020.102525
Received 21 November 2020; Accepted 24 November 2020
Available online 8 December 2020
1079-9796/© 2020 Elsevier Inc. All rights reserved.
1. Introduction

Corona virus disease 2019 (COVID-19) is caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus which originated in Wuhan, China. With the 2nd wave of COVID being reported in a lot of countries, better understanding of disease is very important. The spectrum of COVID-19 varies from asymptomatic cases to acute respiratory distress syndrome (ARDS) and death [1]. Secondary bacterial pneumonias, thrombotic complications, myocardiits, and gastrointestinal involvement are more prevalent in those with comorbidities such as hypertension, diabetes, cardiac disease, cancer and age > 70 years [2].

Patients with hematological malignancies present a group of vulnerable patients. Hirsch et al has demonstrated that patients with hematological malignancies are at a higher risk of respiratory tract infections and severe complications [3]. These patients are often immunocompromised because of the disease, chemotherapy and hematopoietic stem cell transplant (HSCT) used for the treatment of these diseases. This further adds to the increased risk of complications and mortality [4]. Various studies have reported a higher mortality of 32-40% in patients with hematological malignancies and concomitant COVID infection [5-8], as more and more cases are being reported our understanding of disease is improving. However, we are still in dilemma with regards to various aspects of COVID infections in hematological diseases. With 55 million people affected and 1.3 million mortalities as of 17 November 20, India has second highest number of patients affected worldwide [9]. We present the largest retrospective series from India with an aim to identify risk factors, associated with more severe disease and mortality.

1.1. Objectives

Primary objective of study was to analyse the 14-day and 28-day mortality in this population. Secondary objectives were to correlate age, comorbidities and remission status with severity and outcome.

2. Patients & methods

This was a retrospective multicentre observational study conducted in 11 centres treating hematological malignancies across India. Patients with malignant hematological disorders either newly diagnosed, or on ongoing therapy or follow-up at any of the participating centres were included. Patients were included irrespective of COVID-19 severity, need for hospitalisation or outpatient management and remission status of primary hematological disorder. Patients diagnosed with COVID 19 infection from 15 March to 30 Sep 2020 were enrolled in the study. A diagnosis of SARS-CoV-2 infection was based on quantitative real-time reverse transcriptase-polymerase chain reaction (qRT-PCR) of nasal and/or oropharyngeal swabs. Repeat testing was performed based on institutional protocols. Baseline demographic data including comorbidities, severity of illness, remission status, ongoing therapy were extracted from electronic/manual health records and entered in common Microsoft Excel spreadsheet format. All centres submitted their data in anonymised form to central repository (RN). Any follow-up queries were sent on email and sheet modified accordingly. One centre with 4 patients was excluded due to inability to respond to queries generated. Fig. 1 shows the CONSORT diagram. Data was coded centrally and sent to SM for statistical analysis. Patients received various treatment regimens as per physician discretion or institutional protocol in accordance with the national guidelines for the management of COVID-19, issued by the government from time to time [10]. A variety of medicines were used in these patients and included hydroxychloroquine (HCQ), remdesivir, favipiravir, other broad spectrum antibiotics, steroids (methylprednisolone or dexamethasone), tocilizumab and oxygen support/ventilation, convalescent plasma therapy as required [11]. Criteria for classifying patients into severe category were per the clinical management protocols of government of India [7]. Outcomes including time to negativity and death were recorded.

2.1. Inclusion criteria

Patients with hematological malignancies with COVID-19 infection confirmed with RT-PCR were included. Patients were required to have at least 14 days follow-up from first positive test.

Fig. 1. CONSORT diagram of the study.
2.2. Exclusion criteria

Patients with benign hematological disorders were excluded. Any patient lacking sufficient clinical information or less than 14 days follow-up was excluded. Patients diagnosed COVID-19 based on only radiological criteria or with indeterminate COVID status were excluded.

3. Statistical analysis

Data was described in percentages for categorical variables and as the mean ± standard deviation and median in case of continuous variables. For categorical data, comparisons were made by using the Chi square/Fisher exact-test, for quantitative data by t-test/F-test and for non-normally distributed quantitative variables by the Mann-Whitney/Kruskal Wallis test.

Data was analysed with SPSS v 23 software. P value ≤0.05 was considered significant in all statistical evaluations.

4. Results

One hundred and thirty patients with hematological malignancies diagnosed with COVID –19 were analysed. Baseline characteristics are enlisted in Table 1. Median age of our cohort was 49.5 years (2–84) years, with a male predominance (2.5:1). Importantly, one-third of our patients with hematological cancers were elderly (≥65 years) and more than two-fifth had comorbidities. Most of our patients had a lymphoid malignancy (n = 91;70%), Common disorders observed were acute leukemias (42%) (ALL:23%, AML:18%), non-hodgkin lymphomas (26%), multiple myeloma (17%), followed by others [myelodysplastic syndromes (MDS), myeloproliferative neoplasms (MPN), MDS/MPN overlap, Hodgkin lymphoma, Waldenström’s macroglobulinemia]. A small proportion of patients (5%) were post HSCT. At the time of SARS-CoV2 infection, 73% were on active treatment. Active therapies included – chemotherapy (C) alone (73%) (Induction, consolidation - intensive chemotherapy for AML, ALL; hypomethylating agents; CHOP backbone for NHL; ABVD for Hodgkin’s), immunotherapy (I) alone (1%) (rituximab, brentuximab, nivolumab, daratumumab), oral (O) targeted agents (13.6%) (imatinib, dasatinib, nilotinib, ibrutinib, lenalidomide, venetoclax), or combination therapies (11.6%) [chemo-immunotherapy (C+I), chemotherapy+oral (C+O), chemo-immunotherapy+oral (C + I + O)].

5. SARS-CoV2 infection

Most common symptom at time of presentation was fever (77%) followed by cough (50.7%) and breathlessness (49.2%). Fifteen (11%) asymptomatic patients with newly diagnosed hematological malignancy were incidentally detected prior to start of therapy (Table 2). Interestingly, one patient had repeat RT PCR positivity four weeks after prior negativity was 17 days (7-49 days). Seven patients were still positive at last follow-up (range:14-105 days). Nearly three-fourth (n = 96) received antivirals. More than three-fourth of these antivirals included

| Table 1 | Demographic profile of study cohort. |
|-----------------|-----------------|
| Patient characteristics | N (%) |
| **Baseline Characteristics (n = 130)** | |
| **Median age (Range)** | 49.5 years (2–84) years |
| **Elderly (≥ 60 years)** | 47 (36.2) |
| **Children (<18 years)** | 20 (15.4) |
| **Gender** | |
| **Male** | 93 (71.5) |
| **Female** | 37 (28.5) |
| **Comorbidities** | |
| **Hypertension** | 39 (30) (42.3) |
| **Diabetes Mellitus** | 32 (24.6) |
| **Ischemic heart disease** | 22 (17) |
| **Hypothyroidism** | 7 (5.3) |
| **Chronic kidney disease** | 3 (2.3) |
| **Chronic infections [Hepatitis B, Pulmonary tuberculosis, fungal sinusitis]** | 3 (2.3) |
| **Others [Autonomic dysfunction, post-liver transplant, Atrophic gastritis, pancreatitis, irreversible bowel syndrome, Prior VTE]** | 6 (4.6) |
| **≥ 2 comorbid conditions** | 14 (10.7) |
| **≥ 3 comorbid conditions** | 7 (5.4) |
| **Hematological malignancies** | |
| **Diagnosis (N = 130)** | |
| **Acute leukemia** | 55(42.3) |
| **Acute myeloblastic leukemia** | 24 (18.5) |
| **Acute lymphoblastic leukemia** | 31 (23.8) |
| **Myelodysplastic syndrome (MDS)** | 10 (7.7) |
| **Myeloproliferative neoplasm (MPN)** | 4 (3) |
| **MDS/MPN overlap** | 1 (0.7) |
| **Hodgkin lymphoma** | 3 (2.3) |
| **Non-hodgkin lymphoma** | 34 (26) |
| **Chronic lymphocy** | 13 (10) |
| **Diffuse large B cell ly** | 8 (6.1) |
| **Follicular I** | 4 (3.1) |
| **Hairy cell leukemia** | 4 (3.1) |
| **Others (GZL, MCL, ATIL, PTCL-NOS, Bl, B-NHL)** | 6 (4.6) |
| **Plasma cell dyscrasias** | 23 (17.7) |
| **Post HSCT** | 6 (4.6) |
| **Autologous HSCT** | 4 (3.1) |
| **Allogeneic HSCT** | 2 (1.5) |
| **Status of Hematological Malignancy (n = 126)** | |
| **Newly diagnosed** | 18 (14.3) |
| **Yet to be assessed (on treatment before assessment)** | 36 (28.6) |
| **Remission (CR/PR)** | 44 (35) |
| **Stable disease (Observation)** | 4 (3.1) |
| **Relapsed/Refractory** | 24 (19) |
| **Therapy status (N = 105)** | |
| **(excluding 18 newly diagnosed, 7 – not available)** | |
| **Active treatment** | 95 (73.1) |
| **No treatment / observation** | 4 (3) |
| **Post treatment - follow up** | 6 (4.6) |
| **Active treatment (n = 95)** | |
| **Chemotherapy (C)** | 70 (53.8) |
| **Immunotherapy (I)** | 1 (0.7) |
| **Oral targeted (O)** | 15 (10) |
| **C + I** | 9 (6.5) |
| **C + O / C + I + O** | 2 (1.5) |

* VTE-Venous thromboembolism, GZL-Gray zone lymphoma, MCL-mantle cell lymphoma, AITL-Angioimmunoblastic lymphoma, PTCL-NOS-Peripheral T cell lymphoma-not otherwise specified, BL-Burkitt lymphoma, B-NHL-non-hodgkin lymphoma, CR-complete remission, PR-partial remission, monotherapy with remdesivir (25%), favipiravir (11%), HCQ(6.2%), while a small fraction of patients (17%) received various combinations. More than 60% subjects received steroids (dexamethasone), and less than one-third received prophylactic anticoagulation. Convalescent plasma therapy was administered in 17/34 patients with severe COVID-19. In data available in 84 patients, median time to RT-PCR COVID-19 negativity was 17 days (7-49 days). Seven patients were still positive at last follow-up (range:14-105 days). Nearly three-fourth (n = 95) of our patients were on antitumor therapy at time of infection, of which nearly two-third (n = 59;64%) had a delay in their subsequent
Severity of infection in patients as per their disease status.

| Severity of infection | Mild | Moderate | Severe | Total |
|-----------------------|------|----------|--------|-------|
| Remission (CR/PR)†    | 24   | 7        | 7      | 38    |
| Relapsed/Refractory   | 11   | 5        | 10     | 26    |
| Newly diagnosed        | 30   | 14       | 13     | 57    |
| Stable disease         | 3    | 2        | 3      | 8     |
| Not assessed / unclear | 0    | 0        | 1      | 1     |

† CR-complete remission, PR-partial remission.

Chemotherapy.

6. Survival

Overall, 20% (n = 26) patients succumbed. 14-day survival and 28-day survival for whole cohort was 85.4% and 80%, respectively (Table 4). One patient succumbed outside the study period on day 39. Importantly, death rate at 1 month was 50% and 60% in relapse/refractory and severe disease cohorts, respectively. One-month OS for mild, moderate and severe COVID-19 infection was 95.6%, 92.8% and 38.2% respectively. Elderly patients (≥ 60 years) (p = 0.009), and severe COVID-19 infection (p = 0.000) had a poor 14-day survival. The 28-day survival was significantly better for patients in remission (p = 0.04), non-severe infection (p = 0.00), and age < 60 years (p = 0.05).

Amongst various hematological disorders, one-month survival was 67% in AML, 86% in ALL, 93% in MDS / MPN, and 78.4% in lymphoma, and plasma cell dyscrasias, respectively. Interestingly, amongst those on active treatment, 36% (n = 4) patients on immunotherapy alone or combinations (n = 11) (I, C + I, C + I + O) succumbed, versus 19.7% of those on chemotherapy (n = 71) (C, C + O). Amongst those with severe disease, administration of remdesivir (55% vs 68% p = 0.49) and/or steroids (66% vs 28.5% p = 0.09) did not improve survival.
cancer [15]. Another study reported higher rates of severe illness (intensive care unit admissions, invasive ventilation, or death) in patients with cancer when compared with others (39 vs. 8%; p = 0.0003) (8). Patients with cancer also developed severe disease symptoms more rapidly compared with others (median 13 vs. 43 days; p < 0.001) [20].

In a Spanish multicenter retrospective observational study which included 367 pediatric and adult patients with hematological malignancies, prognostic factors identified for day 45 overall mortality included age > 70 years, uncontrolled hematological malignancy, ECOG 3–4, neutropenia (< 0.5 × 10⁹/L) and a C-reactive protein (CRP) > 20 mg/dL (9) [14]. In a multicenter, retrospective, cohort study from Italy, 536 patients with COVID-19 and hematological malignancies were compared with the non-COVID-19 cohort with hematological malignancies, and the standardized mortality ratio was 41.3 (38.1–44.9) [21]. Older age, progressive disease status, diagnosis of AML, aggressive NHL or plasma cell neoplasms and severe COVID-19 were associated with worse overall survival [6,18] suggesting that hematological malignancies have worse outcomes than both the general population with COVID-19 and patients with hematological malignancies without COVID-19. In another retrospective metacronic cohort study from France studying the outcome in Covid-19 hospitalized patients with lymphoma, 30-day mortality was associated with being older (age > 70 years) and relapsed/refractory nature of lymphoma [22].

In our cohort, outcome in patients with comorbidities was not different from those without. Median age in our cohort was much younger than other reported studies and half the patients had mild illness. This may have accounted for this lack of association. Similar to our results A European study documented higher mortality (45% vs 1%) in patients more than 60 years age [23]. Patients not in remission had higher mortality compared to patients in remission. Kuderal et al. have also demonstrated worse outcomes in elderly and people whose disease was not in remission [24]. They also established increased all-cause mortality in patients with cancer vs general population. Similarly, García-Suárez et al. observed higher mortalities in elderly patients > 60 years age and with more than 2 comorbidities [25].

In spite the available literature till date, when to treat, how to treat, when to wait, how long to wait, how to predict and manage toxicities, and how to avoid compromising cure rates remains unknown [12]. There have been expert panel recommendations on how best to manage these patients in current pandemic [26]. In the absence of more specific data, potential risk factors for a severe course of the disease should be assumed as for other viral infections: severe immunodeficiency, lymphopenia, long and profound neutropenia, and older age [27,28]. Patients in remission for their hematological malignancy had better survival and recovery from COVID-19 compared to those patients who were not in remission.

Cancer patients generally shed respiratory viruses longer than immunocompetent people and this is probably true for this novel coronavirus as well [29]. Our median time to negative PCR was 17 days (7–49 days) while one patient was still positive till day 105 at last follow-up. This needs to be kept in mind while devising therapy for these patients. Such long waits may not be feasible sometimes.

Considering the risk of contracting COVID-19 infections, a risk-benefit evaluation should be considered, because the patients may be at a high risk of contracting the COVID-19 infection and dying from it and, on the other hand, that patients may be at a high risk of a fatal hematologic disease progression if not treated appropriately and timely. With the aim of reducing the risk of patient’s exposure to the viral infection, alternative strategies have been considered like telemedicine services; a reduction of clinic visits; less intensive chemotherapy and immunotherapy regimens; switch to subcutaneous or oral therapies, rather than intravenous ones; when possible; and postponement of stem cell transplant procedures to a more favorable period [9,30].

8. Limitations
This is a retrospective study. Therefore, complete data was not available for all patients. COVID-19 being a new disease, national guidelines for testing and need for hospitalisation/home isolation were dynamic. Hence, many patients in this study were hospitalized, who at the time of writing the manuscript could have been managed as outpatients. Study duration was wide and treatment guidelines were dynamic over this time period. Data was collected from multiple centres with different expertise and facilities to handle complications.

These limitations not withstanding we are able to identify important prognostic markers in relatively large cohort of hemat-oncology patients across different regions of India.

9. Conclusions
Elderly patients with hematological malignancy and severe covid-19 have worst outcomes specially when disease is not in remission.

Declaration of competing interest

None.

References
[1] CDC Guidelines-Treatment Guidelines, Updated: July 30, 2020; https://www. COVID-19treatmentguidelines.nih.gov.
[2] A. Juan, J.R. Siordia, Epidemiology and clinical features of COVID-19: a review of current literature, J. Clin. Virol. 127 (2020) 104357.
[3] H.H. Hirsch, R. Martino, K.N. Ward, M. Boechk, H. Einsatz, P. Ljungman, Fourth European conference on infections in Leukaemia (ECLG-4): guidelines for diagnosis and treatment of human respiratory syncytial virus, parainfluenza virus, metapneumovirus, rhinovirus, and coronavirus, Clin. Infect. Dis. 56 (2013) 258–266.
[4] Samuel M Rubinstein, Jeremy L Warner; COVID-19 and haematological malignancy: navigating a narrow strait; The lancet.com; Haematology Vol 7 October 2020.
[5] F. Malard, A. Genthon, E. Bristos, Z. van de Wynaert, Z. Marjanovic, S. Ikhlief, A. Banet, S. Lapiusan, S. Sestilli, E. Corre, et al., COVID-19 outcomes in patients with hematologic disease, Bone Marrow Transplant. (2020), https://doi.org/10.1038/s41409-020-0931-4.
[6] L. Scarch, T. Chatzikonstantinou, G.M. Rigolin, G. Quaresmini, M. Motta, C. Vitale, J.A. Garcia-Marco, J.A. Hernandez-Rivas, F. Miras, M. Baile, et al., COVID-19 severity and mortality in patients with chronic lymphocytic leukemia: a joint study by ERIC, the European research initiative on CLL, and CLL campus, Leukemia. (2020), https://doi.org/10.1016/j.leukres.2019.10.001.
[7] Glenthoj A., Jakobsen, L.H., Sengelov, H., Ahmad, S.A., Qvist, K., Reeves, A., et al., SARS-CoV-2 infection among patients with haematological disorders: Severity and one-month outcome in 66 Danish patients in a nationwide cohort study. Eur. J. Haematol. 2020 Sep 16. doi:10.1111/ejh.13519. Online ahead of print.
[8] R. Lattentor, H. Yildiz, D. Geeref, S. Bailly, J.C. Yombi, COVID-19 in adult patients with hematological disease: analysis of clinical characteristics and outcomes. Indian J Hematol Blood Transfus 7 (2020) 1–5, https://doi.org/10.1007/s12288-020-01318-4. Online ahead of print.
[9] https://www.worldometers.info/coronavirus/ accessed Nov 17, 2020.
[10] Ministry of Health & Family Welfare. Clinical Management Protocol: COVID-19 version 5 [Internet]. MoHFW.gov.in (web archive link, 23 October 2020). [cited 23 October 2020]. Available from: https://www.mohfw.gov.in/pdf/Up datedClinicalManagementProtocolforCOVID-19date30072020.pdf.
[11] Agrawal A, Mukherjee A, Kumar G, Chatterjee P, Bhattacharj Mallik P; PLACID Trial Collaborators. Convalescent plasma in the management of moderate COVID-19 in adults in India: open label phase II multicentre randomised controlled trial (PLACID Trial).BMJ. 2020 Oct 22;371:m3939. doi: https://doi.org/10.1136/bmj.m3939.
[12] Isidori A, de Leval L, Gergis U, Musto P, Porcu P; Management of patients with hematologic malignancies during the COVID-19 pandemic: practical considerations and lessons to be learned. Front Oncol Front Oncol 2020 Aug 14:1069. doi: https://doi.org/10.3389/fonc.2020.01439.
[13] W. Guan, Z. Ni, Y. Hu, W. Liang, C. Ou, J. He, et al., Clinical characteristics of coronavirus disease 2019 in China, N. Engl. J. Med. 382 (18) (2020 Apr 30) 1708–1720.
[14] J.L. Pihana, R. Martino, I. García-García, R. Parody, M.D. Morales, G. Benzo, et al., Risk factors and outcome of COVID-19 in patients with hematological malignancies, Exp Hematol Oncol 9 (1) (2020) 1–16.
[15] W. He, L. Chen, L. Chen, G. Yuan, Y. Yang, W. Chen, et al., COVID-19 in persons with haematological cancers, Leukemia. 34 (6) (2020 Jun) 1637–1645.
[16] R. Foà, M. Bonifacio, S. Chiaretti, A. Curti, A. Candoni, C. Fava, et al., Ph+ acute lymphoblastic leukaemia in Italy during the Covid-19 pandemic: a campus ALL study, Br. J. Haematol. 190 (1) (2020 Jul) e3–e5.

[17] A. Cuneo, L. Scarfo, G. Reda, M. Varettoni, F.M. Quaglia, M. Marchetti, et al., Chronic lymphocytic leukemia management in Italy during the covid-19 pandemic: a campus CLL report, Blood. 136 (6) (2020 Aug 6) 763–766.

[18] M. Brecchia, E. Abruzzese, M. Bocchia, M. Bonifacio, F. Castagnetti, C. Fava, Campus CML working group, et al., Chronic myeloid leukemia management at the time of the COVID-19 pandemic in Italy. A campus CML survey [online ahead of print.], Leukemia. 34 (4) (2020 Aug) 2266–2267.

[19] S. Paul, C.R. Rausch, N. Jain, T. Kadia, F. Ravandi, C.D. DiNardo, et al., Treating leukaemia in the time of COVID-19, Acta Haematol. 11 (2020 May) 1–13.

[20] W. Liang, W. Guan, R. Chen, W. Wang, J. Li, K. Xua, et al., Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China, Lancet Oncol. 21 (3) (2020 Mar 1) 335–337.

[21] F. Passamonti, C. Cattaneo, L. Arcaini, R. Bruna, M. Cavo, F. Merli, et al., Clinical characteristics and risk factors associated with COVID-19 severity in patients with haematological malignancies in Italy: a retrospective, multicentre, cohort study, Lancet Haematol. 7 (10) (2020 Oct 1) e737–e745.

[22] Lamure S, Duléry R, Blasi RD, Chauchet A, Laureana C, Deau-Fischer B, et al. Determinants of outcome in Covid-19 hospitalized patients with lymphoma: a retrospective multicentric cohort study. eClinicalMedicine 2020 Oct;27:100549. doi: https://doi.org/10.1016/j.eclinm.2020.100549.

[23] J. van Doesum, A. Chinea, M. Pagliaro, M.C. Pasquini, T. van Meerten, M. Bakker, et al., Clinical characteristics and outcome of SARS-CoV-2-infected patients with haematological diseases: a retrospective case study in four hospitals in Italy, Spain and the Netherlands. Leukemia. 34 (9) (2020) 2536–2538.

[24] N.M. Kuderer, T.K. Choueiri, D.P. Shah, Y. Shyr, S.M. Rubinstein, D.R. Rivera, et al., Clinical impact of COVID-19 on patients with cancer (CCC19): a cohort study, Lancet. 395 (2020) 1907–1918.

[25] Julio García-Suárez, Javier de la Cruz, Ángel Cedillo, Pilar Llamas, Rafael Duarte, Víctor Jiménez-Yuste et al. Impact of hematologic malignancy and type of cancer therapy on COVID-19 severity and mortality: lessons from a large population-based registry study. J Hematol Oncol 2020 Oct 8;13(1):133. doi:https://doi.org/10.1186/s11609-020-09970-7.

[26] Jain A, Singh C, Dhawan R, Jindal N, Mohindra R, Lad D, et al. How to use a prioritised approach for treating hematological disorders during the COVID-19 pandemic in India? Indian J Hematol Blood Transfus. 2020 Jun;36(4):1–11.

[27] Q. Wang, N.A. Berger, R. Xu, When hematologic malignancies meet COVID-19 in the United States: infections, death and disparities, Blood Rev. 9 (2020 Nov) 100775.

[28] A.M. Zeidan, P.C. Boddu, M.M. Patnaik, J.P. Bewersdorf, M. Stahl, R.K. Rampal, et al., Special considerations in the management of adult patients with acute leukemias and myeloid neoplasms in the COVID-19 era: recommendations from a panel of international experts, Lancet Haematol. 7 (8) (2020 Aug 1) e601–e612.

[29] N. Lehners, J. Tabatabai, C. Prieur, M. Wedde, J. Puthenparambil, B. Weissbrich, et al., Long-term shedding of influenza virus, parainfluenza virus, respiratory syncytial virus and nosocomial epidemiology in patients with hematological disorders, PLoS One 11 (2) (2016), e0148258.

[30] https://ishbt.com/pdf_files/ISHBT%20COVID-19%20Resource_ver1_25.08.2020.pdf Accessed Nov 19, 2020.