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Comparison of depressive symptoms between patients with myeloproliferative neoplasms without the Philadelphia chromosome treated with interferon alpha and patients with chronic myelogenous leukemia treated with tyrosine kinase inhibitors

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Summary

Aim. The aim of the study was to compare the occurrence of depressive symptoms between a group of patients with myeloproliferative neoplasms (MPN) – essential thrombocythemia, polycythemia vera, and primary myelofibrosis – treated with interferon alpha, and patients with chronic myelogenous leukemia (CML) treated with tyrosine kinase inhibitors (TKI) and to check whether individual side effects may contribute to the occurrence of depressive symptoms.

Material and methods. The study involved 175 adult patients with MPN (n = 84) and CML (n = 91) who had been treated with interferon alpha or TKI for a minimum of 3 months. The study used the David Goldberg Questionnaire (GHQ-28), the Four-Dimensional Questionnaire (4DSQ), and our own survey.

Results. Approximately 40% of patients with MPN and almost 20% of patients with CML obtained moderately to strongly elevated scores on the depression scale. The analysis revealed no statistically significant differences between women and men. Bone and joint pain, nausea and indigestion, fatigue, cramps and muscle aches, and diarrhea were side effects that affected the possibility of developing depressive symptoms in both groups. Common predictors of depressive symptoms were the number of side effects, type of illness, and age. The older the person was, the greater the severity of depressive symptoms.

Conclusions. There are significant differences in the prevalence of depression between patients with CML and MPN. Specific side effects of interferon alpha and TKI treatments influence the occurrence of depressive symptoms. No association between interferon treatment and the development of depression was confirmed.

Key words: depressive disorders, myeloproliferative neoplasms, interferon alpha

Introduction

Myeloproliferative neoplasms (MPN) are a group of hematological diseases, which include chronic myelogenous leukemia – with typical Philadelphia chromosome and *BCR::ABL1* gene and Philadelphia-negative disorders, i.e., polycythemia vera (PV), essential thrombocythemia (ET) and primary myelofibrosis (MF) [1, 2]. Due to the presence of the Philadelphia chromosome, chronic myelogenous leukemia is treated separately [3]. Patients with Ph-negative MPN and CML may experience a variety of systemic symptoms such as itching, night sweats, fever, fatigue, easy bruising, and splenomegaly [4]. Treatment depends mainly on the type and stage of the disease, the patient's age, and comorbidities [5]. In patients with MPN, interferon alpha (IFNα) is most often used [6, 7], while in patients with CML, tyrosine kinase inhibitors (TKI) – including imatinib, dasatinib, nilotinib, bosutinib, and ponatinib – are the primary treatment [8, 9]. In the remaining patients, other treatments are used, including pharmacological treatments (hydroxyurea, JAK-2 inhibitors, acetylosalicylic acid), phlebotomy (as a first-line treatment in PV), chemotherapy, radiotherapy, or stem cell transplantation [10, 11].

It is worth noting that not only the disease itself, but also the treatment used, can cause troublesome side effects. In the case of IFNα treatment, apart from hematological, neurological, and rheumatological effects, the most common side effects are: fatigue, loss of appetite, nausea, diarrhea, myalgia, skin rash, and headaches [12, 13], and in the case of TKI, the most common are: increased risk of infection, skin changes, fatigue, bruising, diarrhea, loss of appetite, and water retention [14, 15]. The occurrence of such troublesome side effects of TKI or IFNα treatment may lead to the discontinuation of therapy [7, 16].

The existing literature extensively describes the occurrence of depressive disorders in hemato-oncological patients [17, 18]. Depressive disorders represent a significant clinical issuein patients with hematopoietic cancer, regardless of the stage, type of treatment, or treatment phase [19, 20]. Both the cancer itself (along with its mental and physical comorbidities) [21] and the side effects of treatment may contribute to the development of depressive and anxiety symptoms [22, 23]. In addition, some studies indicate that the side effects of IFNα treatment, in particular pegylated IFNα, may contribute to the development of depressive disorders [24].

The Bioethics Committee at the Jagiellonian University in Krakow approved the study (No. 1072.6120.113.2020). Each participant obtained information about the study and gave their written consent to participate in the study.

Aim

The aim of the study was to compare the occurrence of depressive symptoms between a group of patients with MPN (essential thrombocythemia, polycythemia vera, and primary myelofibrosis) treated with interferon-alpha and patients with chronic myelogenous leukemia (CML) treated with tyrosine kinase inhibitors and to check whether individual side effects may contribute to the occurrence of depressive

symptoms. In addition, differences between groups were analyzed in terms of age, sex, number of side effects, treatment duration, and the severity of depressive symptoms in relation to individual side effects. The goal of the study was not to diagnose depressive disorders, but to assess the risk of their development during treatment with IFNα and TKI.

Material and methods

The study was carried out at the Hematology Department of the Jagiellonian University Hospital (SU) in Krakow and the Clinic of Hematology, Blood Cancer, and Bone Marrow Transplantation in Wrocław. The study involved 175 adult patients with MPN or CML who had been treated with IFNα or TKI for a minimum of 3 months. The patients were diagnosed with essential thrombocythemia, polycythemia vera, primary myelofibrosis, or chronic myeloid leukemia. The selection of patients was purposeful, and each patient was assessed once. The exclusion criteria included psychiatric or psychological (psychotherapeutic) treatment during the study period or within 3 months prior, discontinuation of IFNα / TKI treatment or switching to another drug, starting treatment with IFNα / TKI during the study or up to 3 months before its start, and experiencing symptoms similar to those listed in the questionnaire for at least one month prior to starting treatment with IFNα or TKI. The mean age in the study group was 49 years (*SD* = 14.507). Detailed characteristics of the studied groups are presented in Table 1.

Table 1. **Description of the studied groups**

Variable		***Me* ± *SD***	**(min-max)**
Age (years)		49.00 ± 14.507	(20 – 82)
Treatment duration (years)		10.00 ± 5.8199	(2 – 26)
Number of side effects		4.00 ± 2.564	(0 – 11)
Type of disease		n	%
Chronic myelogenous leukemia (CML)		91	51.4
(Ph)– Myeloproliferative neoplasms (MPNs)		84	48.6
Variable		n	%
Sex	Female	118	67.4
	Male	57	32.6

Me – median; *SD* – standard deviation; *n* – number

Research tools

The sociodemographic questionnaire, including questions about age, sex, place of residence, marital status, education, type and duration of disease, and side effects of treatment, categorized by periods and their duration. The list of side effects associated with IFNα and TKI treatment was created based on the results of studies on their effects and toxicity [12, 15, 25–27].

David Goldberg's General Health Questionnaire (GHQ-28) was used to assess mental health in adults and to analyze four symptom dimensions of mental disorders: depression, anxiety, somatic symptoms, and social dysfunction. Each scale contains 7 questions, and a maximum of 21 points can be obtained. The reliability of the Polish adaptation of the GHQ-28, assessed using Cronbach's alpha coefficient, ranges from 0.91 to 0.93. The criterion validity falls within the range of 0.59 to 0.61 [28, 29]. This study focused on one dimension of mental health: depressive symptoms. The study used a modified Likert scale ranging from 0 to 3 points.

The Four-Dimensional Symptom Questionnaire (4DSQ), measuring the intensity of current depressive, anxiety, somatic, and distress symptoms. The reliability coefficient of the test (Cronbach's alpha) ranges from 0.82 to 0.88 [30]. This study focused on the analysis of one of the four dimensions: depressive symptoms, for which the maximum number of points is 12.

The nomenclature of the "depression" scales in both questionnaires should be interpreted as referring to depressive symptoms. These instruments are screening tools and do not provide a clinical diagnosis.

Statistics

We compared categorical variables between the MPN and CML patients, men and women, and individual side effects of IFN-alpha and TKI treatment by using the Mann–Whitney U test and the χ^2 test. Cramer's V coefficient was used to determine the strength of the relationship between the measurable features. Cohen's *d* coefficient was used to determine the effect size between the variables. A p-value = 0.05 was considered statistically significant. Multiple linear regression analysis was conducted to assess the impact of each variable on the depression scores.

Results

A total of 175 patients with MPN ($n = 84$) and CML ($n = 91$) were examined. Table 2 presents the severity of depressive symptoms measured by the 4DSQ in both groups.

Table 2. **Severity of depressive symptoms in patients with MPN and CML, measured by the 4DSQ**

	Depression			
	MPN (n = 84)		CML (n = 91)	
	n	%	n	%
Not present	50	61.9	75	82.4
Moderate	24	28.6	9	9.9
High	8	9.5	7	7.7
Total	84	100	91	100

n – number

The analysis of the occurrence of depressive symptoms in patients with CML and MPN showed that approximately 40% of patients with MPN and nearly 20% of patients with CML obtained a moderately or strongly elevated score on the depression scale (Table 2).

Table 3 presents the results of the Mann-Whitney U test measuring differences in the intensity of depressive symptoms in patients with MPN and CML.

Table 3. **Differences between MPN and CML patients in the intensity of depressive symptoms measured by the 4DSQ and GHQ-28**

Mental condition	CML (*n* = 91)	*MPN* (*n* = 84)	*p*	*U*	*Z*
	Me (Q1-Q3)	Me (Q1-Q3)			
GHQ-28					
Depressive symptoms	4.0 (2.0-8.0)	2.0 (0.0-5.0)	<0.001	2340.00	-4.457
4DSQ					
Depression	0.0 (0.0-1.0)	0.5 (0.0-3.75)	0.003	4687.50	2.950

Me – median; Q1 – lower quartile; Q3 – upper quartile; *p* – statistical significance; *U* –Mann-Whitney U statistic; *Z* – standardized Z-value of the Mann–Whitney test

Patients with MPN differ from patients with CML in the severity of depressive symptoms. In the case of the depression symptoms scale measured by the GHQ-28, patients with MPN obtained lower scores than patients from the second group. However, on the depression scale measured by the 4DSQ, patients with CML obtained lower scores than those with MPN.

In another analysis, the differences between men and women in the severity of depressive and anxiety symptoms measured by the 4DSQ and GHQ-28 were examined. The analysis showed no statistically significant differences.

Next, the incidence and relationships of individual side effects of TKI and IFNα treatment between patients with MPN and CML were investigated (Fig.1, Table 4).

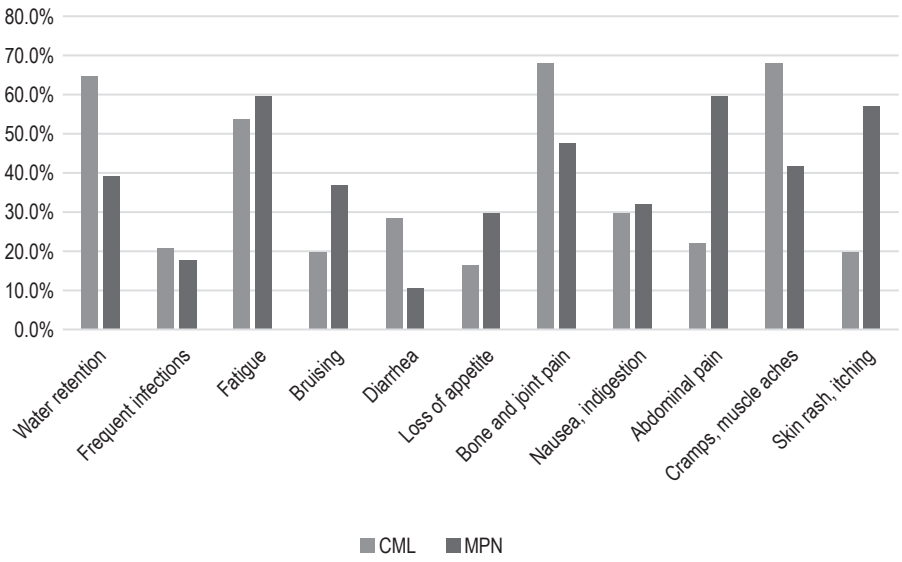

Figure 1. **Occurrence of side effects of TKI and IFNα treatment among patients with MPN and CML**

Table 4. **Associations in the occurrence of individual side effects of TKI and IFNα treatment between patients with MPN and CML**

Side effect	χ^2	*df*	*p*	Cramér's V
Water retention	11.436	1	<0.001	0.256
Frequent infections	0.255	1	0.614	0.038
Fatigue	0.573	1	0.449	0.057
Bruising	6.354	1	0.012	0.191
Diarrhea	8.705	1	0.003	0.223
Loss of appetite	4.368	1	0.037	0.158
Bone and joint pain	7.559	1	0.006	0.208
Nausea, indigestion	0.125	1	0.724	0.027
Abdominal pain	25.656	1	<0.001	0.383
Cramps, muscle aches	12.383	1	<0.001	0.266
Skin rash, itching	25.958	1	<0.001	0.385

χ^2 – chi-square test; df – degrees of freedom, *p* – statistical significance; V – Cramér's V coefficient

The occurrence of side effects of TKI and IFNα treatment in the form of water retention, bruising, diarrhea, loss of appetite, bone and joint pain, abdominal pain,

muscle aches and cramps, as well as skin rash and itching, depends on the type of disease. Water retention, diarrhea, bone and joint pain, muscle aches and cramps are more common in CML patients than in MPN patients. Conversely, bruising, loss of appetite, abdominal pain, skin rash, and itching were more frequent in MPN patients.

Another analysis was conducted to examine the impact of side effects of TKI and IFNα treatment in patients with MPN and CML on the severity of depressive symptoms measured by the GHQ (Table 5).

Table 5. **Standardized and non-standardized coefficients of the linear regression model for predicting the impact of side effects in patients with MPN and CML on the severity of depressive symptoms measured by the GHQ-28**

	Variable	*B*	*SE*	*β*	*t*	*p*
1	Constant	2.641	0.409		6.465	<0.001
	Bone and joint pain	2.905	0.549	0.373	5.295	<0.001
2	Constant	2.223	0.414		5.374	<0.001
	Bone and joint pain	2.525	0.543	0.325	4.651	<0.001
	Nausea, indigestion	2.037	0.584	0.243	3.486	<0.001
3	Constant	1.679	0.465		3.607	<0.001
	Bone and joint pain	2.292	0.544	0.295	4.213	<0.001
	Nausea, indigestion	1.787	0.585	0.213	3.053	0.003
	Fatigue	1.328	0.547	0.170	2.430	0.016
4	Constant	1.356	0.488		2.776	0.006
	Bone and joint pain	1.749	0.603	0.225	2.902	0.004
	Nausea, indigestion	1.791	0.580	0.214	3.087	0.002
	Fatigue	1.181	0.547	0.151	2.160	0.032
	Cramps, muscle aches	1.210	0.602	0.154	2.010	0.046
5	Constant	1.314	0.485		2.710	0.007
	Bone and joint pain	1.524	0.609	0.196	2.504	0.013
	Nausea, indigestion	1.603	0.583	0.191	2.750	0.007
	Fatigue	1.064	0.545	0.136	1.951	0.053
	Cramps, muscle aches	1.251	0.597	0.159	2.095	0.038
	Diarrhea	1.338	0.676	0.138	1.978	0.050

B – non-standardized coefficient; *SE* – standard error; β – standardized coefficient; *t* – the result of Student's *t*-test; *p* – statistical significance

In the analysis of the impact of individual side effects of IKT and IFNα treatment on the severity of depressive symptoms, as measured by the GHQ-28, the regression

algorithm reached its final solution in step 5. The model was well fitted to the data – $F(5, 169) = 11.77$; $p < 0.001$ and explained 24% of the variance in the dependent variable ($R2_{adj} = 0.236$). Based on the regression coefficients presented in Table 5, it was found that bone and joint pain ($\beta = 0.196$, $p = 0.013$), nausea and indigestion ($\beta = 0.191$, $p = 0.007$), fatigue ($\beta = 0.136$, $p = 0.053$), cramps and muscle aches ($\beta = 0.159$, $p = 0.038$) and diarrhea ($\beta = 0.138$, $p = 0.050$) were side effects that affected the possibility of developing depressive symptoms in both groups. The predictors were positively related to the dependent variable.

The severity of depressive symptoms in both groups was then examined using the GHQ-28 and 4DSQ, categorized according to the presence of side effects of IFNα and TKI treatment (Table 6).

Table 6. **Severity of depressive symptoms in MPN and CML patients categorized by the presence of side effects of IFNα and TKI treatment**

		Depressive symptoms/depression									
		CML (*n* = 91)			MPN (*n* = 84)						
Side effects	**Test**	***M***	***SD***	***Me***	***M***	***SD***	***Me***	***U***	***Z***	***p***	***d***
Water retention	GHQ	5.98	4.27	5	3.24	3.55	2	577.00	-3.245	0.001	0.68
	4DSQ	1.08	2.13	0	1.85	2.69	1	1173.50	1.829	0.067	-0.33
Frequent infections	GHQ	7.05	5.32	6	4.53	3.38	6	102.50	-1.396	0.167	0.55
	4DSQ	1.63	2.81	0	2.87	2.97	3	188.50	1.677	0.111	-0.43
Fatigue	GHQ	6.80	4.36	7	3.62	3.24	3	688.00	-3.774	<0.001	0.83
	4DSQ	1.10	2.17	0	1.80	2.30	1	1508.00	2.183	0.029	-0.31
Bruising	GHQ	6.44	5.44	4.5	3.19	3.99	0	165.00	-2.428	0.015	0.71
	4DSQ	1.39	2.25	0	2.32	2.88	1	329.50	1.110	0.267	-0.35
Diarrhea	GHQ	7.27	4.89	7	3.67	3.81	3	65.50	-1.955	0.051	0.78
	4DSQ	1.54	2.75	0	1.67	2.00	0	124.00	0.305	0.810	-0.05
Loss of appetite	GHQ	8.07	5.30	8	5.08	3.10	5	124.00	-1.784	0.078	0.73
	4DSQ	1.73	3.10	0	2.36	3.10	1	221.00	0.995	0.361	-0.21
Bone and joint pain	GHQ	6.24	4.14	6	3.83	3.47	3	806.00	-2.988	0.003	0.62
	4DSQ	0.94	2.05	0	2.08	2.56	1	1647.00	3.153	0.002	-0.50
Nausea, indigestion	GHQ	7.67	4.88	7	4.41	3.43	3	221.00	-2.493	0.013	0.77
	4DSQ	1.56	2.64	0	1.85	4.71	1	409.00	0.834	0.404	-0.11
Abdominal pain	GHQ	7.05	4.95	5.5	4.14	3.88	3	320.50	-2.351	0.019	0.75
	4DSQ	2.00	2.92	0	1.92	2.47	1	532.00	0.438	0.662	0.03

table continued on the next page

Cramps, muscle aches	GHQ	6.13	4.32	6	4.51	3.51	3	860.00	-1.697	0.090	0.40
	4DSQ	0.94	2.05	0	2.34	2.66	1	1484.50	3.391	<0.001	-0.62
Skin rash, itching	GHQ	5.39	3.17	5	3.54	3.55	2	282.50	-2.173	0.030	0.54
	4DSQ	0.33	0.77	0	2.04	2.77	0	577.00	2.348	0.019	-0.71

Me – median; *M* – mean, *SD* – standard deviation; *p* – statistical significance; *U* –Mann-Whitney U statistic; *Z* – standardized Z-value of the Mann–Whitney test; *d* –Cohen effect size

The analysis of the severity of depressive symptoms in MPN and CML patients, categorized by the presence of side effects of IFNα and TKI treatment, showed that water retention, fatigue, bruising, bone and joint pain, nausea and indigestion, abdominal pain, cramps and muscle aches, and skin rash and itching differentiated the groups in terms of depressive symptom severity.

The results of the analysis examining the relationship between the severity of depressive symptoms and age, sex, type of illness, number of side effects, and duration of treatment are presented in Table 7.

Table 7. **Multidimensional associations between the severity of depressive symptoms (measured by the 4DSQ and GHQ-28) and age, sex, type of illness, number of side effects, and duration of treatment in patients with MPN and CML**

External variables	***B****	***p***
Depressive symptoms GHQ-28		
Duration of treatment	-0.009	0.840
Age	0.055	0.012
Number of side effects	0.694	<0.001
Sex (male vs. female)	-0.501	0.343
Disease (CML vs. MPN)	-1.849	0.003
Adjusted R^2= 0.343 (F = 19.143)		
Depressive symptoms 4DSQ		
Duration of treatment	-0.016	0.588
Age	0.022	0.130
Number of side effects	0.215	0.001
Sex (male vs. female)	-0.026	0.943
Disease (CML vs. MPN)	1.205	0.005
Adjusted R^2 = 0.089 (F = 4.412)		

*crude regression coefficients

In the conducted analyses of the relationship between the severity of depressive symptoms as measured by the GHQ-28 and 4DSQ tests and age, sex, type of disease, number of side effects, and duration of treatment in both groups, the regression models explained 34% and 9% of the variance. Based on the results presented in Table 7, it was found that in patients with MPN and CML, a common predictor of depression severity across both questionnaires was the number of side effects (GHQ-28: $B = 0.694$; $p = <0.001$; 4DSQ: $B = 0.215$; $p = 0.001$). The more side effects a patient experienced, the greater the intensity of all the symptoms of mental disorders.

An important predictor of the severity of depressive symptoms was also the type of illness (GHQ-28: $B = – 1.849$; $p = 0.003$; 4DSQ: $B = 1.205$; $p = 0.005$). The results varied depending on the research tool used. The analysis also showed that age was an unfavorable prognostic factor for the occurrence of depressive symptoms ($B = 0.055$; $p = 0.012$). The older the person was, the greater the severity of depressive symptoms.

Discussion

The results of many studies indicate that depressive disorders are common among patients with CML and MPN [18]. A comparative analysis of the occurrence of depressive symptoms between patients with MPN ($n = 34$; 38.1%) and those with CML ($n = 16$; 17.6%) showed that patients differ in the severity of depressive symptoms (Table 2, Table 3). So far, these groups have not been compared with each other, but existing research indicates that among patients with MPN [31, 32] and patients with CML [18, 33], depressive disorders are more severe than in the healthy population and are often associated with anxiety disorders. The study by Shi et al. [18] and Phillips et al. [34] showed that approximately 37% of CML patients treated with TKI experience depression. On the other hand, in the study by Xu et al. [35], the incidence of depression was lower and amounted to 13.2%. In a study by Brintzenhofe-Szoc et al. [36] on mixed symptoms of anxiety/depression in a large group of cancer patients, it was noted that hemato-oncological patients report a higher intensity of anxiety and depression than patients with other types of cancer.

Differences between the groups may be primarily due to variations in treatment for these diseases and differences in survival prognosis. In the case of patients with CML, the introduction of TKI therapy has resulted in their survival now being comparable to that of healthy individuals [37], as TKI treatment is less toxic and burdensome than treatment for MPN [38]. Depending on the questionnaire used, results indicate that both MPN and CML patients experience depressive symptoms; therefore, it cannot be clearly confirmed that treatment with IFNα promotes the development of depression. It is worth noting that both the authors' own research and the studies cited above used different tools to assess depression. In addition, discrepancies between the results suggest that the use of different assessment tools can lead to varying outcomes. Therefore, it is recommended to use at least two research tools [39].

The results of the authors' own research showed that women do not differ from men in the severity of depressive symptoms. Some studies also do not show such a correlation [31, 40]; however, most researchers point to significant sex differences,

which may be influenced by factors as duration of treatment, age and the quantity and quality of social support. Women and men tend to play different social roles, function differently in society, and have varying levels of emotional sensitivity [41]. Typically, women show greater severity of depressive symptoms among both MPN [32] and CML patients [18, 42]. These differences may also be influenced by the use of different research tools for measuring depression. For example,Padrnos et al. [40] used the Patient Health Questionnaire-2 (PHQ-2); McFarland et al. [31] and Brochmann et al. [32] used the Hospital Anxiety and Depression Scale (HADS); Shi et al. [18] used the Self-Rating Depression Scale (SDS); and Efficace et al. [43] used the Psychological General Well-Being Index (PGWB-S).

The results of the study showed that the occurrence of side effects from TKI and IFNα treatment – such as frequent infections, fatigue, and nausea and indigestion – was not dependent on the type of disease (Table 5). In both CML and MPN patients, these three side effects occurred at similar frequencies. The authors' own findings are consistent with the results of existing literature, which frequently reports that patients with MPN and CML often experience infections and/or fatigue [17, 44]. These symptoms are associated with the deterioration of immunity caused by the disease and its treatment.

The analysis of the severity of depressive symptoms in MPN and CML patients, divided according to the presence of side effects from IFNα and TKI treatment, showed that water retention, fatigue, bruising, bone and joint pain, nausea and indigestion, abdominal pain, cramps and muscle aches, as well as skin rash and itching were associated with differences in the severity of depressive symptoms (Table 6). The results are consistent with studies by McFarland et al. [45], Phillips et al. [34], and Padrnos et al. [40], which describe the impact of disease symptoms and treatment on the likelihood of depression. Particular attention is paid to fatigue, which is a very common side effect of both the disease itself and treatment with TKI or interferon alpha [46].

Based on the results presented in Table 7, it was found that in patients with MPN and CML, the common predictor of the occurrence of depressive symptoms measured by both questionnaires was the number of side effects. The greater the number of side effects experienced by the patient, the higher the severity of all mental health symptoms. An important predictor of the severity of depressive symptoms was also the type of illness, but the results varied depending on the assessment tool used. The authors' findings are consistent with related studies indicating that the occurrence of treatment side effects affects patients' quality of life and may contribute to the development of mental disorders [47]. The study by McFarland et al. [45] on the relationship between the physical and psychological symptom burden in patients with Philadelphia chromosome-negative MPN emphasizes that the physical burden of symptoms in MPN patients is related to psychological symptoms, while the occurrence of depression is linked to the overall burden of physical symptoms.

The analysis also showed that an unfavorable prognostic factor for the occurrence of depressive symptoms in both groups was age. The older the patient, the greater the severity of depressive symptoms. Research by Constanzo et al. [48] describes the differences in perceiving and experiencing cancer, indicating that older patients scored significantly worse than younger ones in various aspects of mental health and quality of

life. The study by Gibek and Sacha [42] showed that older patients with CML have more severe depressive symptoms than younger ones, while the study by Efficace et al. [43] showed no relationship between age and the severity of depressive symptoms. Gibek et al. [17], Brochmann et al. [32], and Padrnos et al. [40] indicate that elderly patients with MPN have a lower chance of depression compared to younger patients. These discrepancies may stem from differences in disease type and treatment approaches.

The conducted research has several limitations. The GHQ-28 and 4DSQ screening tests used do not diagnose depression; rather, they are only used to assess patients for depressive symptoms. For the diagnosis of depression, the ICD-11 or DSM-5 diagnostic criteria should be used. Therefore, the obtained results are exploratory and require further investigation. Another limitation is that patients were examined only once, which is related to the type of study. In future research, patients should undergo similar examinations several times to determine whether the introduction of a psychological or psychiatric intervention, as well as the duration or modification of treatment, affects the patient's condition. A further limitation was the use of an unvalidated symptom burden measurement tool developed by the authors. The rationale was to use this questionnaire in two types of patient groups.

Conclusions

Depressive symptoms are common in patients with CML and MPN. Additionally, individual side effects of IFNα and TKI treatments have an impact on the occurrence of these symptoms. The severity of depressive symptoms differed between the groups, depending on the assessment tool used. In both groups, fatigue and frequent infections are characteristic side effects. Significant predictors of the risk of developing depression included the number of side effects, age (older patients), and the underlying disease (CML or MPN, depending on the assessment tool). The relationship between IFNα treatment and the development of depression was not confirmed.

Based on the presented results, an increased risk of clinical depression can be observed in the studied patient groups. Routine screening for depression should be implemented in this patient population. Knowledge about possible disorders, as well as improvement of mental health and quality of life in hemato-oncological patients at various stages of treatment, can play a very important role in patient care. The selection of appropriate psychological, psychiatric, or psychotherapeutic support strategies may subsequently help reduce the occurrence or severity of depressive symptoms, improve patients' quality of life, decrease the percentage of patients resigning from treatment due to side effects, and increase the percentage of patients returning to treatment despite experiencing burdensome side effects of treatment.

In the future, this knowledge will guide the development and implementation of appropriate psycho-educational care methods. It may also support the introduction of innovative medical and psycho-educational approaches that address the psycho-oncological needs of the aforementioned patient groups.

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