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Analysis of National Health and Insurance Registers for All-Cause Mortality in Patients with Heart Failure with and without Diabetes Mellitus in Poland in 2012

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Background: This retrospective study aimed to analyze all-cause mortality in patients with heart failure with and without diabetes mellitus in 2012 in Poland using data from the National Health Fund [Narodowy Fundusz Zdrowia] (NFZ), the Central Register of the Insured [Centralna Baza Ubezpieczonych] (CBU), and the Polish Universal Electronic System for Registration of the Population (PESEL).





Material/Methods: Between 1st January 2012 and 31st December 2012, data were analyzed from the NFZ, CBU, and PESEL to include all patients with a primary diagnosis of heart failure, with and without diabetes mellitus and all-cause mortality data. Structured Query Language (SQL) was used to retrieve and manage data from NFZ, CBU, and PESEL.

Results: In Poland, 32.58% of 201,586 patients with a primary diagnosis of heart failure who died in 2012 also had a diagnosis of diabetes mellitus. The overall mortality rate in men with heart failure and diabetes was eight times higher than for men with heart failure without diabetes. The overall mortality rate in women with diabetes and heart failure was 5.5 times higher compared with women with heart failure without diabetes. More than 90% of deaths in female patients with heart failure, with or without diabetes, occurred in women >60 years. For male patients with heart failure with or without diabetes, 70% of deaths occurred in men >60 years.

Conclusions: These findings support the need for continued prevention programs, early diagnosis, and treatment of diabetes, and highlight the increase in mortality for patients with heart failure and diabetes.

MeSH Keywords: **Diabetes Mellitus • Heart Failure • Mortality • Poland • Registries**

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Background

Studies from North America and Western European countries have shown that patients with heart failure who also have diabetes mellitus have a two-fold to a three-fold higher risk of mortality due to cardiovascular disease compared with non-diabetic patients [1,2]. Heart failure affects between 0.4–2.0% of the general population, with the most common cause being ischemic heart disease (IHD) due to coronary artery atherosclerosis, which is exacerbated by diabetes [3,4].

In 2017, Siedlecki et al. reported the findings from the COMMIT-HF registry study of mortality in patients with heart failure, with and without diabetes, and reported that the prevalence of diabetes was 42.6% [2]. Diabetes resulted in impaired renal function and cardiac function, and was associated with increased mortality in patients with heart failure, even with improvements in the management of heart failure [2]. A recent study from the USA that analyzed health insurance registry data showed that patients with heart failure and diabetes were at increased risk for rehospitalization and mortality due to heart failure [3]. Recent evidence-based clinical guidelines on diabetes, pre-diabetes, and cardiovascular disease have been published by the European Society of Cardiology (ESC) and the European Association for the Study of Diabetes (EASD) [4]. These guidelines highlight the importance of prevention, early diagnosis, and optimal management of patients with diabetes, and the association with increased mortality in patients with diabetes who also have ischemic heart disease (IHD) and heart failure [4]. In 2013, 17.3 million people died from heart failure, and the overall mortality rate was estimated at 293.2/100,000 people in the general population [5,6]. Diabetes and heart failure often coexist, and diabetes is an independent risk factor for the development of heart failure [7,8]. Observational studies have also identified diabetes as a risk factor for increased mortality in patients with heart failure [9,10].

Medical care in Poland is administered by the Ministry of Health and is funded by the National Health Fund [Narodowy Fundusz Zdrowia] (NFZ), and the Central Register of the Insured [Centralna Baza Ubezpieczonych] (CBU) [11–13]. Health services are provided by the primary healthcare system, including specialist ambulatory care and hospital care. The organization of these services is determined by the ordinances of the President of the NFZ [14,15]. Also, the Polish Universal Electronic System for Registration of the Population (PESEL), which is a number assigned to each citizen in Poland from birth, allows for demographic and health characteristics to be analyzed [16].

There have previously been several studies that have analyzed health outcome population data in Poland for specific diseases.

This study aimed to investigate patients with heart failure with and without diabetes mellitus in Poland in 2012. According to data from the Polish Central Statistical Office, [Główny Urząd Statystyczny] (GUS), in 2012, the population of Poland was 38,533,789, including 18,651,441 men and 19,882,348 women [17]. We have previously reported that between 1st January 2012 and 31st December 2012, the urban and rural population of Poland included 2,227,453 patients with diabetes, including 975,364 men and 1,252,089 women [18]. In 2012 the general population without a diagnosis of diabetes in Poland was 36,306,336, including 17,676,077 men and 18,630,259 women [17,18]. According to Rywik et al., 28,304 female patients and 19,558 male patients in Poland died due to heart failure in 2010 [19]. In 2010, the mean mortality rate due to heart failure in men was 267.8 deaths/100,000 population, and the mean mortality rate due to heart failure in women was 175 deaths/100,000 population [19].

Although there have been several previously published studies to compare mortality data between patients with and without diabetes and mortality in heart failure, all-cause mortality in patients with heart failure, with and without diabetes, remains to be studied in Poland. Therefore, this retrospective pilot study aimed to analyze all-cause mortality in patients with heart failure with and without diabetes mellitus in 2012 in Poland using data from the NFZ, CBU, and PESEL.

Material and Methods

Study design, data sources, and ethical approval

A retrospective study was undertaken of overall mortality, or all-cause mortality, in patients with heart failure with and without diabetes mellitus. The study was conducted between 1st January 2012 and 31st December 2012. Data were analyzed for 2012 in Poland from the National Health Fund [Narodowy Fundusz Zdrowia] (NFZ), the Central Register of the Insured [Centralna Baza Ubezpieczonych] (CBU), and the Polish Universal Electronic System for Registration of the Population (PESEL) [16]. Structured Query Language (SQL) was used to select patients in the NFZ, CBU, and PESEL databases. Because this was a retrospective study of anonymized patient data, informed patient consent was not required.

Identification of patients with heart failure and all-cause mortality

Patients with a primary diagnosis of heart failure were identified in the NFZ database using the International Classification of Diseases 10th Edition (ICD-10) coding system. The ICD-10 categories included: heart failure (code I50); congestive heart failure (code I50.0); left ventricular failure (code I50.1); heart failure,

Table 1. All-cause mortality in patients with a primary diagnosis of heart failure with and without diabetes in Poland in 2012, based on data from the National Health Fund (NFZ) and the Central Register of the Insured (CBU).

Subpopulation	Men	Women	Total
Mortality in patient without diabetes	63,758	72,143	135,901
Mortality in patient with diabetes	28,669	37,016	65,685
Total	92,427	109,159	201,586

unspecified (code 150.9). Structured Query Language (SQL) was used to select patients in the NFZ database, and the PESEL number was established as a unique identifier [16]. Also, by using the PESEL number, it was possible to identify all patients with a primary diagnosis of heart failure who died in 2012 from the CBU database. By cross-referencing the data, all-cause or overall mortality was determined in this patient group.

Identification of patients with diabetes mellitus

Patients with a diagnosis of diabetes mellitus were identified from data in the NFZ database on diabetes-related health services provided for individuals with a main diagnosis of diabetes. The following qualifiers (extensions) were used to identify all relevant patients: E12.X, insulin-dependent diabetes; E11.X, noninsulin-dependent diabetes; E12.X, diabetes and nutrition; and E13.X, diabetes, unspecified. Extension code E14.X, diabetes, unspecified or identified by prescription for medical treatment, included: A10A.X, prescribed insulin; and A10B.X, oral anti-diabetic medication, or the use of special-ized diagnostic tests.

Statistical analysis

Data were analyzed using PQStat version 1.6 software (<https://pqstat.pl>). Student's t-test for independent variables was used for comparison between groups. Data were expressed as the mean±standard deviation (SD). Prevalence data were expressed as the percentage (%). Population data were expressed as the number per 100,000 in the general or patient population. Statistical significance was determined using 95% confidence interval (CI) values. A P-value <0.05 was considered to be statistically significant.

Results

All-cause mortality in patients with a primary diagnosis of heart failure with and without diabetes mellitus in Poland in 2012

Based on analysis of data from the National Health Fund [Narodowy Fundusz Zdrowia] (NFZ), and the Central Register of the Insured [Centralna Baza Ubezpieczonych] (CBU) [11–13],

the all-cause mortality rate for patients with heart failure with and without diabetes mellitus were compared with the general population of Poland in 2012. Table 1 shows the numbers of patients with a primary diagnosis of heart failure who died from different causes in Poland between 1st January 2012 to 31st December 2012, including the subpopulations with and without diabetes, and men and women (Table 1).

In Poland, 32.58% of 201,586 patients with a primary diagnosis of heart failure who died in 2012 also had a diagnosis of diabetes mellitus. The all-cause or overall mortality rate in men with heart failure and diabetes was eight times higher than for men with heart failure without diabetes. The overall mortality rate in women with diabetes and heart failure was 5.5 times higher compared with women with heart failure without diabetes. More than 90% of deaths in female patients with heart failure, with or without diabetes, occurred in women >60 years.

For male patients with heart failure with or without diabetes, 70% of deaths occurred in men >60 years. Overall mortality rates in both men and women with heart failure and diabetes who were >60 years of age were almost twice as high as mortality rates in non-diabetic patients. For men with heart failure and diabetes who were <60 years of age, the overall mortality rate was 25 times higher than for men in the same age group without diabetes. For women with heart failure and diabetes who were <60 years of age, the overall mortality rate was 20 times greater than for women in the same age group without diabetes.

The number and percentage of deaths in patients with heart failure in selected age groups with and without diabetes based on gender in Poland in 2012

Table 2 shows the prevalence and the number of deaths from all causes in patients with a primary diagnosis of heart failure in subpopulations with and without diabetes, according to gender. Analysis of the NFZ and CBU databases showed that 201,586 people with a primary diagnosis of heart failure died in 2012 in Poland, including 92,427 men and 109,159 women. Among those who died during this period, 135,901 patients with heart failure were not diagnosed with diabetes compared with 65,685 patients who were diagnosed with diabetes.

Table 2. The number and percentage of deaths in patients with heart failure in selected age groups with and without diabetes based on gender in Poland in 2012.

Age group	Patients with heart failure without diabetes (number, percentage*)		Patients with heart failure with diabetes (number, percentage*)	
	Men	Women	Men	Women
<50 years	1,403 (2.20%)	426 (0.59%)	279 (0.97%)	93 (0.25%)
51–60 years	10,131 (15.89%)	3,744 (5.19%)	7,505 (26.18%)	1,758 (4.75%)
>61 years	52,224 (81.91%)	67,973 (94.22%)	20,885 (72.85%)	35,165 (95.00%)
Total	199,466 (100.00%)	256,428 (100.00%)	2,117 (100.00%)	35,165 (100.00%)

* Percentages to two decimal places.

Table 3. Overall mortality rates in patients with heart failure with and without diabetes per 100,000 population in 2012 in Poland.

Subpopulation of patients with heart failure	Total (men and women)	Men	Women
Without diabetes	374.32	360.70	387.24
With diabetes	2,526.56	2,939.31	2,205.03
P-value*	P<0.001	P<0.001	P<0.01

* Student's t-test for independent variables.

Mortality data showed that 32.58% of all-cause deaths were in patients with heart failure and diabetes, and 45.85% were men. The prevalence of male patients with heart failure and diabetes was 43.65%, and the prevalence of men with heart failure without diabetes was 46.91%. The mean age distribution of the patients with heart failure who died in 2012 for patients with and without diabetes included: men without diabetes (75.17±11.02 years); men with diabetes (73.34±9.95 years); women without diabetes (80.78±9.17 years); and women with diabetes (78.40±8.57 years). Men in both subpopulations were significantly younger at the time of death than women (P<0.01). Men with heart failure but without diabetes were significantly older at death than men with heart failure and diabetes (P<0.01). Women with heart failure and without diabetes were significantly older at the time of death than women with heart failure who had diabetes (P<0.01) (Table 2).

Overall mortality rates in patients with heart failure with and without diabetes in 2012 in Poland

Table 3 shows the overall mortality rates in patients with a primary diagnosis of heart failure for patients with and without diabetes mellitus, between 1st January 2012 and 31st December 2012. The mortality rates were calculated separately per 100,000 people from a given subpopulation. The mortality rate in patients with and without diabetes who were <60 years of age was almost three times higher in men compared with women. Overall mortality rates for patients with a primary diagnosis of heart failure in the Polish population in 2012,

based on data from the NFZ and CBU per 100,000 people in the general population was 523,14 deaths, which included 495,55 male deaths and 549,02 female deaths. There was no significant difference between overall mortality rates due to heart failure in men and women in 2012 (P=0.311) (Table 3).

Overall mortality rates in patients with heart failure with and without diabetes in 2012 in Poland according to age and gender

Table 4 shows the calculated overall mortality rates for the patients with a primary diagnosis of heart failure in the two subpopulations with and without diabetes, and in the two age groups, <60 years and >60 years of age, and in men and women. More than 80% of deaths in men with heart failure without diabetes and more than 90% of deaths in women with heart failure without diabetes occurred after the age of 60 years. In the subpopulation of patients with diabetes, more than 70% of deaths in men and more than 90% of deaths in women occurred after the age of 60 years.

The overall mortality rate due to heart failure in diabetic patients of both genders was 25.256 deaths/100,000 of all diabetic patients, and the overall mortality rate in non-diabetic patients of both genders was 37.432 deaths/100,000 all non-diabetic patients (P<0.001). All-cause mortality rates in the subpopulation of male and female patients without diabetes showed no significant difference. The all-cause male mortality rate in the subpopulation of patients with heart failure

Table 4. Overall mortality rates in patients with heart failure with and without diabetes per 100,000 population in 2012 in Poland according to age and gender.

Age group	Patients with heart failure, without diabetes		Patients with heart failure, with diabetes	
	Men	Women	Men	Women
<60 years	78.96 N*=11,534	28.07 N=4,170	2,047.72 N=7,784	562.55 N=1,851
>60 years	1,701.35 N=52,224	1,800.84 N=67,973	3,508.69 N=20,885	3,809.64 N=35,165
P-values**	P<0.001	P<0.001	P<0.01	P<0.01

* Number of patients; ** Student's t-test for independent variables.

and diabetes was 293.931/100,000 diabetics. The all-cause mortality rate in the subpopulation of female patients with heart failure and diabetes was 220.503/100,000 diabetics. The mortality rate for men was significantly higher than for women ($P<0.001$).

The mortality rate of female patients with heart failure and diabetes was significantly higher than for non-diabetic female patients ($P<0.001$). The mortality rate of men with heart failure and diabetes was significantly higher than for non-diabetic men ($P<0.001$). The overall risk of mortality due to heart failure in male patients with diabetes was eight-fold higher compared with non-diabetic men. However, the overall risk of mortality due to heart failure in female patients with diabetes was more than five-fold higher compared with non-diabetic women.

The overall mortality rate due to heart failure in diabetic men <60 years of age was 2047.72 deaths/100,000 men with diabetes, and in non-diabetic men, the mortality rate was 28.07/100,000 men without diabetes. The overall mortality rate due to heart failure in this age group of male patients with diabetes was 25 times greater compared with the non-diabetic subpopulation ($P<0.001$). The overall mortality rate due to heart failure in women with diabetes <60 years of age in Poland in 2012 was 562.55 deaths/100,000 women with diabetes, and in non-diabetic women, the mortality rate was 78.96/100,000 women without diabetes. The overall mortality rate due to heart failure in this age group of female diabetic patients was 20 times greater compared with the non-diabetic subpopulation ($P<0.001$).

The overall mortality rate due to heart failure in male patients with diabetes >60 years in Poland was 3,508.69/100,000 diabetic patients, and in people without diabetes, the mortality rate was 1,701.35/100,000 non-diabetics. The overall mortality rate due to heart failure in this age group in male patients with diabetes was two times greater than the subpopulation of non-diabetic men with heart failure ($P<0.001$).

The all-cause mortality rate due to heart failure in female patients with diabetes aged >60 years in Poland in 2012 was 3,809.69 deaths/100,000 diabetics, while in patients with heart failure without diabetes, the mortality rate was 1,800.84/100,000 non-diabetics. Calculated overall mortality rate due to heart failure in this age group in female patients with diabetes was more than twice that of the subpopulation of non-diabetic women ($P<0.001$). Significantly increased overall mortality rates were found in men <60 years of age with and without diabetes compared with the overall mortality rates in women in this subpopulation ($P<0.001$). Also, significantly higher overall mortality rates were found in both diabetic and non-diabetic men aged <60 years, and in the population of diabetic patients compared with overall mortality rates in women in this subpopulation ($P<0.001$). The overall mortality rates of men and women with heart failure in the non-diabetic subpopulation <60 years of age were not significantly different (Table 4).

Discussion

In this retrospective study, all-cause mortality in patients with heart failure with and without diabetes mellitus was analyzed in 2012 in Poland using data from the National Health Fund [Narodowy Fundusz Zdrowia] (NFZ), the Central Register of the Insured [Centralna Baza Ubezpieczonych] (CBU), and the Polish Universal Electronic System for Registration of the Population (PESEL).

The findings from this study showed that in Poland, 32.58% of 201,586 patients with a primary diagnosis of heart failure who died in 2012 also had a diagnosis of diabetes mellitus. The all-cause or overall mortality rate in men with heart failure and diabetes was eight times higher than for men with heart failure without diabetes. The overall mortality rate in women with diabetes and heart failure was 5.5 times higher compared with women with heart failure without diabetes. More than 90% of deaths in female patients with heart failure, with

or without diabetes, occurred in women >60 years. For male patients with heart failure with or without diabetes, 70% of deaths occurred in men >60 years. Overall mortality rates in both men and women with heart failure and diabetes who were >60 years of age were almost twice as high as mortality rates in non-diabetic patients. For men with heart failure and diabetes who were <60 years of age, the overall mortality rate was 25 times higher than for men in the same age group without diabetes. For women with heart failure and diabetes who were <60 years of age, the overall mortality rate was 20 times greater than for women in the same age group without diabetes.

The findings from the present study can be compared with those of Rywik et al., who reported that in 2010 in Poland 28,304 female patients and 19,558 male patients died due to heart failure [19]. Also, in 2010, the mean mortality rate due to heart failure in men was 267.8 deaths/100,000 population, and the mean mortality rate due to heart failure in women was 175 deaths/100,000 population [19]. The findings from the present study showed that in 2012 in Poland, the overall mortality rate in both men and women with a primary diagnosis of heart failure was 523.14/100,000 population. For men, the overall mortality rate 495.55/100,000 population, and for women, the overall mortality rate was 549.55/100,000 population. In women, the mean age at death was significantly higher in both subpopulations, with and without diabetes, compared with the mean age for men. In 2012 in Poland, women comprised 54.15% of all deaths for patients with a primary diagnosis of heart failure.

Previous studies have also supported the gender differences in mortality rates from heart failure with and without diabetes mellitus. Some previous studies have shown significantly higher mortality rates in women with heart failure and diabetes mellitus when compared with men [20,21], while other studies have shown significantly higher mortality rates in men [19,22–24]. Regardless of gender, patient age appears to have a significant effect on mortality rates due to heart failure [19–24]. Rywik et al. showed that in 2010 in Poland, for men >74 years of age, the mortality rate was 1257.3 deaths/100,000 population, in the age range of 65–74 years, the mortality rate was 322.4 deaths/100,000 population, and in the age range of 45–64 years, the mortality rate was 95.6 deaths/100,000 population [19]. Rywik et al. also showed that in women >74 years of age in 2010 in Poland the mortality rate was 1179.2 deaths/100,000 population, in the age range of 65–74 years, the mortality rate was 150.4 deaths/100,000 population, and in the age range 45–64 years, the mortality rate was 27.8 deaths/100,000 population.

The number of patients with heart failure has been underreported in population and health registries and clinical studies,

and it may also be assumed that in 2012, there were more patients with heart failure than were included in the NFZ and CBU. Reports from the Netherlands have shown that mortality due to heart failure represented 5% of all deaths [25], while publications from other countries estimate mortality from heart failure as between 1–3% [21,26,27] in 2005, Goldacre et al. reported the findings from a study that analyzed death certification in England between 1979–2003 and showed that reduced mortality rates from coronary heart disease were not associated with increased mortality from heart failure [20]. Death due to ischemic heart disease (IHD) in men between 1974–2003 in England was 2.7%, and mortality due to heart failure was 2.9% [20]. In the same study, mortality due to IHD in women was 2.3%, and mortality due to heart failure was 2.6% [20]. In Poland, between 2008–2013, the mortality rates in patients with diabetes were more than twice the overall mortality rates in non-diabetic patients [28]. The mean number of deaths in men with diabetes (29.70±31.03 deaths per 1,000 patients per year) was significantly higher than the mean number of deaths in women with diabetes (21.11±33.43 per 1,000 patients per year) [28].

In the present study, diabetes was diagnosed in 19% of patients with known heart failure, and overall mortality rates in both men and women with heart failure and diabetes who were >60 years of age were almost twice as high as mortality rates in non-diabetic patients. The inclusion of an analysis of not only gender but also age was an important consideration in the present population study. For example, in the 1970s, the Framingham study investigated the epidemiology of diabetes in congestive heart failure but did not include patients >50 years of age [29,30,31]. Massi et al. reported that between 1968–1992 in the USA, mortality rates due to heart failure showed a four-fold increase, and 90% of deaths due to heart failure were in patients >65 years of age [32]. The findings from the present study showed a more than two-fold higher overall mortality due to heart failure in patients >60 years with a diagnosis of diabetes mellitus compared with patients without diabetes for both men and women. However, overall mortality in diabetic men with heart failure aged <60 years was 25 times greater than for non-diabetic men. The mortality rate in women with heart failure and diabetes who were <60 years of age was 20 times greater than for non-diabetic women with heart failure. The overall mortality rate for the subpopulation of men with diabetes and heart failure was eight times greater than the mortality rate in the subpopulation of men without diabetes. In this study, the overall mortality rate in the entire subpopulation of women with heart failure and diabetes was more than five times greater than for women with heart failure without diabetes. These findings are supported by previous studies that have shown a two-fold to a three-fold increased risk of mortality due to heart failure in the diabetic population [1,2,21,22,33].

The findings from the present study support recently published findings on the impact of diabetes mellitus on clinical outcomes in patients with heart failure due to ischemic and non-ischemic cardiac disease [2,3,31–34]. In 2016, a study from the Swedish Heart Failure Registry (SwedeHF) analyzed patient data from 2003 to 2011 and showed that heart failure was a severe complication of type 2 diabetes mellitus [34]. Diabetes was shown to predict mortality, even without ischemic heart disease, and cardiac revascularization did not reduce the impact of diabetes on patient mortality [34]. The findings from the present study also support recent recommendations made by the European Society of Cardiology (ESC) and the European Association for the Study of Diabetes (EASD) on the importance of prevention and control of diabetes in patients with heart failure due to the increase in mortality rates in this patient population [4].

This study had several limitations. This preliminary or pilot study analyzed registry data for one year for the population of Poland. The study analyzed overall mortality rates, or all-cause mortality, in 2012 for patients with a primary diagnosis of heart failure and with data obtained from the NFZ and CBU databases. Two populations were studied, patients with diabetes and patients without diabetes. The aim of the study was to assess overall mortality rates, not mortality due to heart failure alone, and it would be important to identify mortality from heart failure as an outcome in future studies. A limitation of using patient databases and registries is that the quality of the data is dependent on the physicians who input the data into the database. Therefore, there may have been missing or limited clinical data in the NFZ and CBU databases, and errors in data input could not be excluded. The NFZ and CBU databases lacked details on the cause of death, and there

were also coding problems that prevented the analysis of patient comorbidities. This study did not analyze the effects of the complications of diabetes, such as renal impairment, and did not evaluate the effects of patient management and control of blood glucose levels. The impact of treatment regimens in patients with diabetes, including insulin-dependency, were not analyzed in this study.

Conclusions

This retrospective study aimed to analyze all-cause mortality in patients with heart failure with and without diabetes mellitus during the year 2012 in Poland. Data were analyzed from the National Health Fund [Narodowy Fundusz Zdrowia] (NFZ), the Central Register of the Insured [Centralna Baza Ubezpieczonych] (CBU), and the Polish Universal Electronic System for Registration of the Population (PESEL). The findings supported the association between increased mortality rates associated with diabetes mellitus in patients with heart failure. The study findings also highlighted the differences in mortality from heart failure, with and without diabetes, in men and women, and patients younger and older than 60 years. These findings support the need for continued early diagnosis, and treatment of diabetes and prevention programs and support the importance of the control of diabetes in patients with heart failure, not only in Poland but also in other developed countries.

Conflict of interest

None.

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