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Risk factors for reoperation after surgical treatment for degenerative spinal disease in Poland: a nationwide retrospective study of 38,953 hospitalisations

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ABSTRACT

Introduction. Degenerative spinal disease (DSD) is one of the most common musculoskeletal conditions and a leading cause of sickness absence. It also contributes significantly to the global burden of disease. The aim of this study was to assess the frequency of reoperation after surgical treatment of DSDs in Poland, and to identify risk factors for reoperation.

Material and methods. A retrospective analysis of hospitalisations for DSD in 2018 that were reported to Poland's National Health Fund (NHF) was performed. Reoperations reported within 365 days of hospital discharge were identified. Demographic factors and multimorbidities were included in the analysis. A logistic regression model was then performed to assess risk factors for reoperations.

Results. In 2018, 38,953 surgical hospitalszations for DSD were reported. A total of 3,942 hospitalised patients (10.12%) required reoperation within 365 days. Patients requiring reoperation were predominantly female (female-to-male ratio 1.34:1) and elderly (mean age of reoperated patients 56.66 years, mean age of other patients 53.24). The percentage reoperated upon correlated with multiple diseases (from 8.81% in the group of patients without comorbidities to 15.31% in the group of patients with three or more comorbidities). The risk of reoperation was most increased by comorbid depression, neurological diseases, obesity, and older age. The risk of reoperation was reduced by instrumented spinal surgery, surgery in a neurosurgical unit, and hospitalisations other than same-day surgery.

Conclusions. Reoperations within a year after DSD surgical treatment are common. Identifying risk factors for reoperation, including those related to the presence of comorbidities and the phenomenon of multimorbidity, can be an important tool in reducing reoperation rates.

Key words: degenerative spinal disease, multimorbidity, reoperation, risk factors, spinal surgery

Introduction

Degenerative spinal disease (DSD) is one of the most common musculoskeletal disorders and the leading cause of sickness absenteeism. It also contributes significantly to the global burden of disease. The results of the 2017 Global Burden of Disease Study indicate that low back pain remains the leading cause of disability worldwide [1]. DSD significantly reduces a patient's quality of life due to its generation of pain, reduction in physical function, and chronic course. The treatment of DSD patients represents a heavy burden on the healthcare system, including primary healthcare, specialised outpatient

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healthcare, inpatient treatment and rehabilitation. Low back pain, which was the most common clinical manifestation of DSD in 2000 in the United Kingdom, was found to be the most common single cause of sickness absenteeism in that country, accounting for 12.5% of all days of incapacity for work [2].

According to an analysis of the causes of sickness absenteeism in Poland in 2012–2016, conducted by the Social Insurance Institution, musculoskeletal and connective tissue disorders (which include DSD) were the second cause of sickness absenteeism after pregnancy, childbirth, and puerperium. Those spinal conditions accounted for 15.3% of total days of absenteeism, showing a marked increase in the years analysed. The lifetime prevalence of complaints associated with DSD is estimated to be up to 80% [2]. The point prevalence rate and annual prevalence rate for low back pain in the general population are estimated to be 18.3% and 38%, respectively [3]. According to analyses conducted as part of the Maps of Health Needs project in 2014, 462,000 cases of DSD were reported in Poland. The reported DSD incidence rate was 1.2% and the reported DSD prevalence rate (cases reported from 2009 to 2014) was 9.2%. In 2014, 68,000 hospitalisations for DSD were reported in Polish hospitals. A total of 1,001,000 DSD patients were treated and 2,004,000 medical consultations were provided. This data refers to services reimbursed by the National Health Fund of Poland (NHF); it does not include services funded from other sources (non-public funds), and is therefore an underestimation of the final rates in Poland.

DSD is the most common reason for spinal surgery [4, 5]. Given the type of lumbar spine pathology in surgically treated patients, the most common indications for surgery in the world include degenerative disc disease (discopathy), spinal canal stenosis, and spondylolisthesis, respectively [6]. Data obtained from the Maps of Health Needs project showed that in Poland, out of 68,000 hospitalisations of DSD patients, hospitalisations combined with surgical treatment comprised 50.1%. Surgical treatment can reduce pain and improve quality of life and overall fitness in many patients. However, it is associated with a risk of complications and adverse events. Surgeries performed for DSD are the most frequently performed surgeries of all.

The effectiveness and safety of surgical treatment for DSD are affected by the eligibility of the patient for surgery, their general health status (i.e. medical risk factors), the experience and knowledge of their surgeon, the type of medical equipment in their treatment centre, their postoperative care, and the quality of rehabilitation [7]. Additional factors include psychological, social, economic and occupational determinants of the patient.

Given the prevalence of DSD and its social and economic consequences, it is crucial to monitor the quality of treatment for DSD. The reoperation rate is one indicator of the quality of treatment in surgery. Reoperation is defined as a subsequent, unplanned surgical intervention. This may involve surgical intervention at the same site, at a different site but due to the same condition, or repair of complications resulting from the initial surgical procedure [8]. Reoperation *per se* is strongly predictive of surgical complications in spinal surgery [9]. An additional burden of other health problems (multimorbidity) may carry an increased risk of surgical failure in DSD patients, including the need for reoperation. According to the World Health Organisation's definition, multimorbidity means the co-occurrence of two or more chronic health problems in one person [10]. Multimorbidity is considered a potentially important adverse predictor in DSD patients treated with surgery, although few publications have investigated this topic. Their interpretations and, above all, references to specific outcomes, are impeded by the fact that different authors use different methods to assess multimorbidity, and their analyses cover a wide range of degenerative spinal disorders (e.g. spinal disc herniation, spinal stenosis, spondylolisthesis) treated with various surgical techniques. Overall health status before surgery is a predictor of the clinical outcome of surgery and of patient satisfaction [9–13].

There have been very few studies on reoperation after spinal surgery in Poland [7, 14–16], so the literature is still scarce. However, some Polish medical institutions provide data to EUROSPINE's International Spine Registry (Spine Tango), founded in 2002 [5]. It should also be noted that there was a specifically Polish registry for monitoring spinal surgical treatment known as Polspine [17]. Unfortunately, due to concerns about the protection of personal data and Poland's General Data Protection Regulation introduced in 2018, the platform and data collection has been stopped, so there is still a need for an active national spinal surgery registry in Poland.

This study aims to evaluate the reoperation rate after surgical treatment for DSD in Poland, and to identify risk factors for reoperation, including comorbidities and other variables.

Material and Methods

Study organisation and eligibility criteria

This study is a retrospective analysis of adult patients operated on for DSD in 2018 in Poland. The study group was identified as consisting of patients hospitalised with a principal diagnosis of DSD defined by ICD-10 codes in accordance with the International Statistical Classification of Diseases and Related Health Problems ICD-10: M43.1, M47, M48, M50, M51, or M53 with extensions. Next it was verified whether the patient's hospitalisation was reported using one of diagnosis-related group (DRG) codes: A22, A23, A27, H51, H52, H53, or H55. Those patients who met both the aforementioned conditions were designated the study group. The group of reoperated patients was identified by the same ICD-10 and DRG codes, provided that they were reported not later than 365 days after the end of the primary hospitalisation.

Ethics statement

This study is part of the Maps of Health Needs project implemented by the Ministry of Health, co-financed by the European Union through the European Social Fund under the Operational Programme Knowledge Education Development

(EU grant number: POWR 05.02.00-00-0149/15-01). The study was conducted in accordance with the tenets of the Declaration of Helsinki with respect to research involving human subjects. The approval of the Bioethics Committee was not necessary. The study protocol was approved by the Polish Ministry of Health, which is authorised under the law of the Republic of Poland to process NHF data.

Study procedure

We defined any spinal surgery (instrumented or non-instrumented) as an index operation and a degenerative spinal disease as an index disease. Distinguishing between instrumented (with implants) *vs*. non-instrumented (without implant) surgery was possible owing to DRG codes reported to the National Health Fund. Reoperation was defined as a consequent spinal surgery performed within 365 days after the end of the primary hospitalisation for spinal surgery.

Our analysis used NHF data concerning the reported inpatient, outpatient, primary healthcare, psychiatric and addiction treatment services, i.e. services reported to the payer in 2017–2019 and relating to prescriptions purchased during the corresponding period. Information concerning patient deaths for the period 2018–2019 was released by the Ministry of Administration and Digitisation.

Several risk factors that have a potential impact on the risk of reoperation were defined based on a literature review and the knowledge and experience of a medical expert. Factors related to medical history and pertaining to the patient's demographic profile were included in the analysis, as was a profile of the facility where the patient was hospitalised. The former group of risk factors includes variables whose definitions were taken from the article by Elixhauser et al. [18]; they are also included in the Elixhauser Comorbidity Index. The latter group of risk factors, the facility profile, includes information concerning for example the range of services provided at the facility, the presence of specific departments, or the facility's classification as a teaching hospital.

Statistical analyses

The statistical analysis included constructing a logistic regression model in which a response variable concerned reoperation for DSD within 365 days of the discharge from hospitalisation associated with the primary surgery, according to explanatory variables. The qualitative variables used in the analysis were recoded for the correct model construction using one-hot encoding. To eliminate the problem of strong multicollinearity, the effect of VIF coefficients was verified and the Pearson's linear correlation coefficients were analysed, as well as the correlation values of any monotonic relationship (including non-linear relationship) by calculating the Spearman's rank correlation coefficients. The Akaike information criterion algorithm was used to identify the model that best fits the data and for extraction of explanatory variables that have the greatest impact on the response variable. The model parameters were estimated using the maximum likelihood estimation. Variables found to be very rare among the analysed cohort were excluded from the analysis. To ensure the evaluation of the quality of the model and to control its level of fit to the data, the considered set of observations was randomly divided into a learning (70%) part and a testing (30%) part. The quality of the resulting classifiers was evaluated using the Area Under ROC Curve (AUC) measure. Logistic regression analysis resulted in odds ratios (OR) that were calculated together with a 95% confidence interval (CI). P-values of less than 0.05 were considered statistically significant. The analysis was performed using Python (version 3.6.5) and R (version 3.6.1) programs.

Results

There were 38,953 surgical hospitalisations for DSD reported in 2018. After 3,942 hospitalisations (10.12%), reoperations within 365 days after hospital discharge were noted (Fig. 1). Figure 2 shows the differences in terms of age distribution compared to surgical hospitalisation for DSD. The mean patient age in the analysed group was 53.59 years. The mean age of patients who underwent reoperation up to one year after hospital discharge was 56.66 years, and the mean age of patients who did not need reoperation was 53.24 years. Figure 3 shows that women were more likely to undergo surgery for DSD than men (134 women compared to 100 men). The mean age of women who needed reoperation was 57.42 years and that of men was 55.62 years. The likelihood of no reoperation decreased evenly within consecutive days of the primary surgery (Fig. 4). The figures characterise the study group, the statistical significance of the differences was tested using logistic regression, and the results are given below.

Table 1 shows comorbidities in patients undergoing surgical hospitalisations for DSD. The most common comorbidities in the study group included spontaneous hypertension (12.58% of patients), diabetes mellitus (11.41% of diabetic patients treated with oral medications and 3.14% of diabetic patients treated with insulin), and chronic respiratory diseases (6.15%).

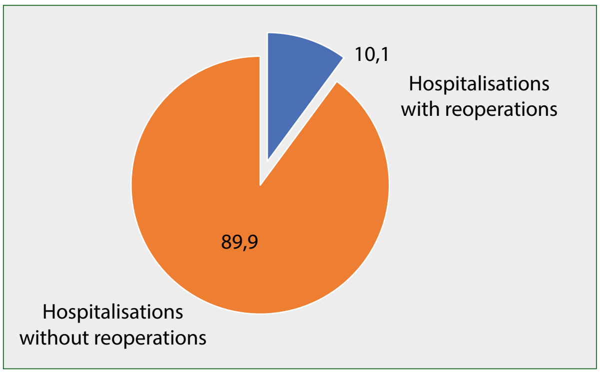

Figure 1. Distribution of hospitalisations compared to reoperations within 365 days of hospital discharge

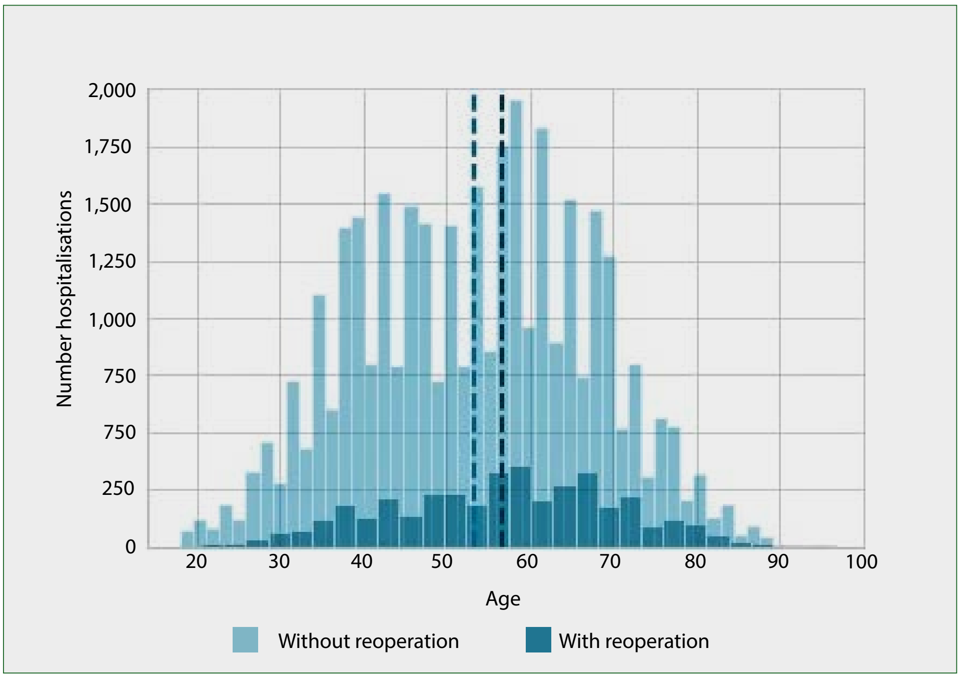

Figure 2. Distribution of hospitalisations with and without reoperation compared to patient age (dashed lines indicate mean age of patients)

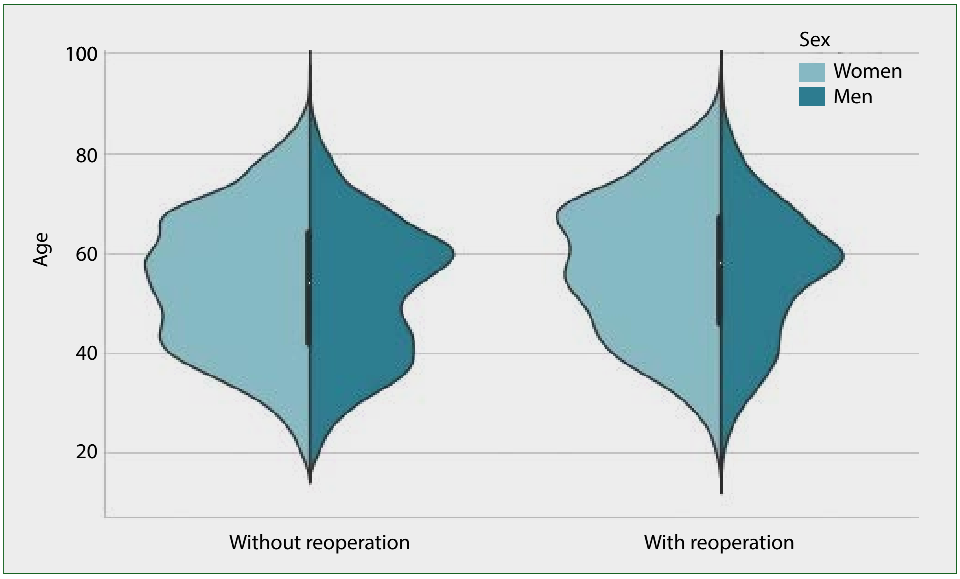

Figure 3. Violin plots showing number of reoperations for DSD according to patient's age and sex. Area under plot corresponds to number of performed reoperations. White dot in middle of plot indicates median age, whereas vertical thick lines indicate quartiles

The highest reoperation rate was reported for patients with severe malnutrition (24%), lymphomata and haematological cancers (21.13%), although the number of patients with these diseases was low and thus they were not included in the model. The highest reoperation rate among the variables included in the further analysis was for patients with diagnoses of metastatic cancer (18.11%), obesity (15.11%), depression (14.76%) and neurological diseases (14.71%). The lowest reoperation rate included patients with HIV infection (0%), iron-deficiency anaemia (5.26%), and psychotic disorders (3.16%). There was also an increasing reoperation rate according to the number of diagnosed comorbidities. In the group of patients without comorbidities, the reoperation rate was 8.81%. When patients suffered from one or two comorbidities, the reoperation rate increased to 11.33%, and when they suffered from three or more comorbidities, the rate was 15.31%.

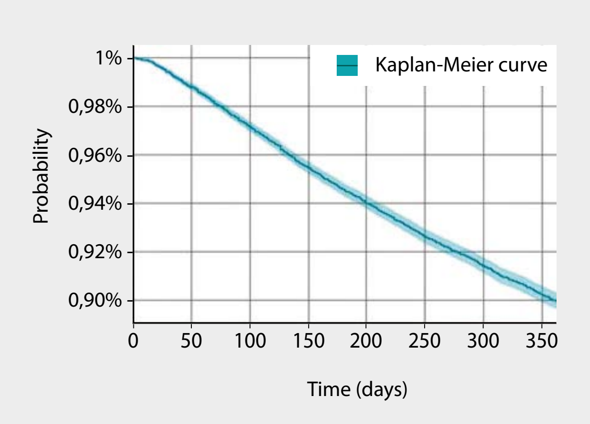

Figure 4. Kaplan-Meier curve showing a decrease in probability of no reoperation as number of days since primary hospital discharge increases

Table 2 shows 24 variables that were included in the logistic regression model. Other variables were eliminated during the initial stages of the analysis. The variables that most strongly increased the likelihood of reoperation included those reporting depression (OR = 1.507, Fig. 5), neurological diseases (OR = 1.426), obesity (OR = 1.401, Fig. 6), and hypertension associated with organ damage (OR = 1.253). Other significant variables that increased the likelihood of reoperation included age (highest likelihood of reoperation for patients aged 70-79 compared to those aged 18-49; OR = 1.225, Fig. 7) and the profile of the facility where the operation was performed (higher likelihood for clinical centres compared to non-clinical ones, OR = 1.101).

Variables that reduce the likelihood of reoperation included the place of residence (i.e. a lower likelihood of reoperation in patients living in rural areas compared to those living in

Table 1. Distribution of variables in study group

Variable	Number of patients	Percentage of patients in study group	Patients with a certain variable who underwent reoperation
Comorbidity variables			
Spontaneous hypertension	4,899	12.58%	606 (12.37%)
Diabetes treated with oral medications	4,443	11.41%	523 (11.77%)
Chronic respiratory diseases	2,397	6.15%	322 (13.43%)
Hypothyroidism	1,772	4.55%	209 (11.79%)
Depression	1,673	4.29%	247 (14.76%)
Arrhythmias	1,547	3.97%	221 (14.29%)
Hypertension associated with organ damage	1,304	3.35%	185 (14.19%)
Diabetes treated with insulin	1,225	3.14%	151 (12.33%)
Non-metastatic cancers	1,174	3.01%	150 (12.78%)
Arthropathies and connective tissue diseases	1,152	2.96%	163 (14.15%)
Peripheral vascular diseases	1,025	2.63%	149 (14.54%)
Neurological diseases	748	1.92%	110 (14.71%)
Heart failure	520	1.33%	72 (13.85%)
Obesity	483	1.24%	73 (15.11%)
Alcoholism	463	1.19%	39 (8.42%)
Liver diseases	441	1.13%	59 (13.38%)
Paralytic syndromes	433	1.11%	32 (7.39%)
Renal failure	340	0.87%	44 (12.94%)
Valvular heart defects	302	0.78%	40 (13.25%)
Drug use	177	0.45%	28 (15.82%)
Water-electrolyte imbalance	109	0.28%	16 (14.68%)
Coagulopathies	101	0.26%	16 (15.84%)
Nutritional-deficiency anaemia	96	0.25%	13 (13.54%)
Psychotic disorders	95	0.24%	3 (3.16%)
Lymphomata and haematological cancers	71	0.18%	15 (21.13%)
Peptic ulcers without bleeding or perforation	62	0.16%	5 (8.06%)
Pulmonary circulatory disorders	53	0.14%	5 (9.43%)
Metastatic cancers	43	0.11%	8 (18.6%)
Iron-deficiency anaemia due to blood loss	38	0.10%	2 (5.26%)
Smoking	31	0.08%	2 (6.45%)

→

Table 1. cont. Distribution of variables in study group

Variable	Number of patients	Percentage of patients in study group	Patients with a certain variable who underwent reoperation
Malnutrition and abnormal weight loss	25	0.06%	6 (24.00%)
Disease caused by HIV	3	0.01%	0 (0.00%)
Demographic variables			
Male	18,020	46.26%	1,679 (9.32%)
age: 50–59 years	9,329	23.95%	961 (10.3%)
age: 60–69 years	9,087	23.33%	1,014 (11.16%)
age: 70–79 years	4,139	10.63%	572 (13.82%)
age: 80–89 years	984	2.53%	161 (16.36%)
Place of residence: countryside	13,698	35.17%	1,197 (8.74%)
Facility profile			
Clinical centres	12,323	31.64%	1,049 (8.51%)
Operations performed in a neurosurgical department	27,921	71.68%	2,310 (8.27%)
Operations performed in an orthopaedic department	8,324	21.37%	970 (11.65%)
Other variables			
Surgeries with an implant	15,034	38.60%	992 (6.6%)
Emergency admission to hospital	6,492	16.67%	606 (9.33%)
Hospitalisation lasting 1–2 days	4,518	11.60%	559 (12.37%)
Hospitalisation lasting 3 days	7,071	18.15%	474 (6.7%)
Hospitalisation lasting 4–7 days	14,903	38.26%	931 (6.25%)
Hospitalisation lasting more than 7 days	8,079	20.74%	598 (7.4%)

Table 2. Results of logistic regression analysis (AUC for learning set = 0.687, AUC for test set = 0.69)

Variable	Coefficient	OR	2.5% OR	97.5% OR	P-value
Metastatic cancers	0.562	1.754	0.677	4.544	0.247
Depression	0.410	1.507	1.266	1.795	< 0.001*
Neurological diseases	0.355	1.426	1.105	1.841	0.006*
Obesity	0.337	1.401	1.019	1.926	0.038*
Hypertension associated with organ damage	0.225	1.253	1.019	1.541	0.033*
Patients aged 70–79	0.203	1.225	1.063	1.412	0.005*
Patients aged 60–69	0.180	1.197	1.070	1.339	0.002*
Patients aged 50–59	0.177	1.194	1.069	1.334	0.002*
Emergency admission to hospital	0.109	1.115	0.995	1.250	0.061
Liver diseases	0.107	1.113	0.777	1.595	0.558
Peripheral vascular diseases	0.105	1.111	0.880	1.403	0.378
Clinical centres	0.096	1.101	1.000	1.213	0.049*
Patients aged 80–89	0.019	1.020	0.805	1.291	0.872
Spontaneous hypertension	–0.048	0.953	0.842	1.079	0.445
Place of residence: countryside	–0.147	0.864	0.790	0.944	0.001*
Surgery with an implant	–0.202	0.817	0.738	0.903	< 0.001*
Operations performed in a neurosurgical department	–0.322	0.724	0.662	0.792	< 0.001*
Intercept*	–0.779	0.459	0.408	0.516	< 0.001*
Psychotic disorders	–0.880	0.415	0.125	1.380	0.151
Hospitalisation lasting 1–2 days	–1.071	0.343	0.298	0.394	< 0.001*
Iron-deficiency anaemia due to blood loss	–1.281	0.278	0.035	2.174	0.222
Hospitalisation lasting more than 7 days	–1.564	0.209	0.182	0.241	< 0.001*
Hospitalisation lasting 3 days	–1.661	0.190	0.164	0.220	< 0.001*
Hospitalisation lasting 4–7 days	–1.761	0.172	0.152	0.195	< 0.001*

*Constant parameter in logistic regression model, does not have a medical interpretation

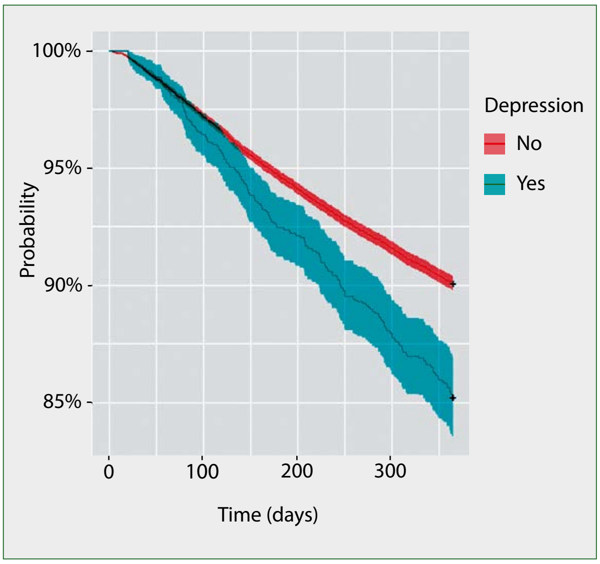

Figure 5. Kaplan-Meier curve showing changes in probability of no reoperation as number of days since hospital discharge increases, according to depression as a patient's comorbidity

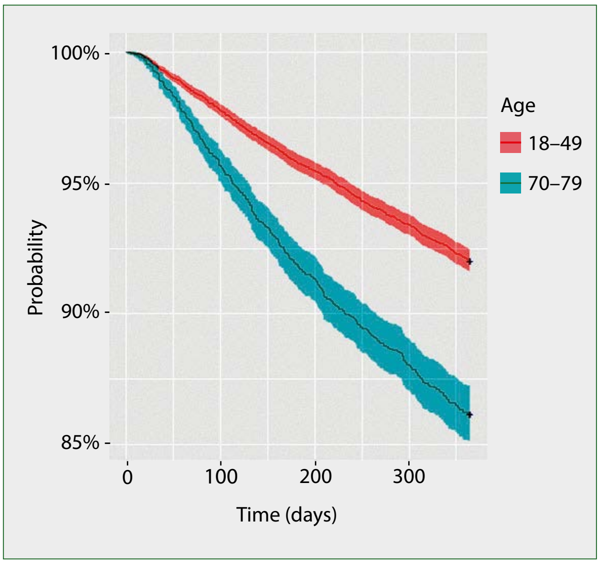

Figure 7. Kaplan-Meier curve shows changes in probability of no reoperation as number of days since hospital discharge increases, according to patient's age group at initial hospitalisation

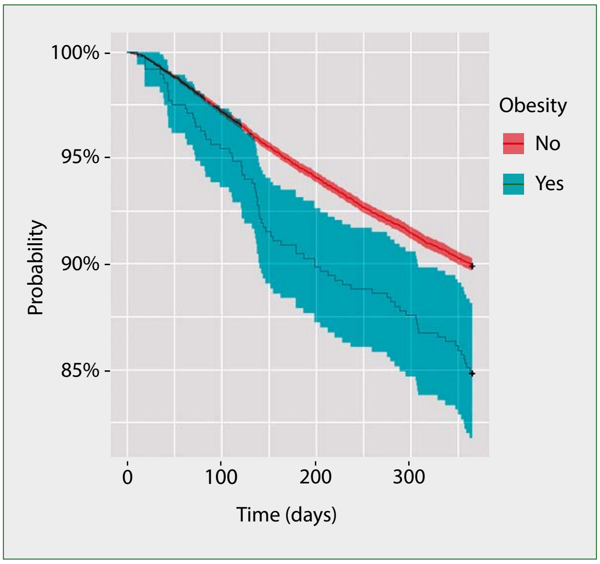

Figure 6. Kaplan-Meier curve showing changes in probability of no reoperation as number of days since hospital discharge increases, according to obesity as a patient's comorbidity

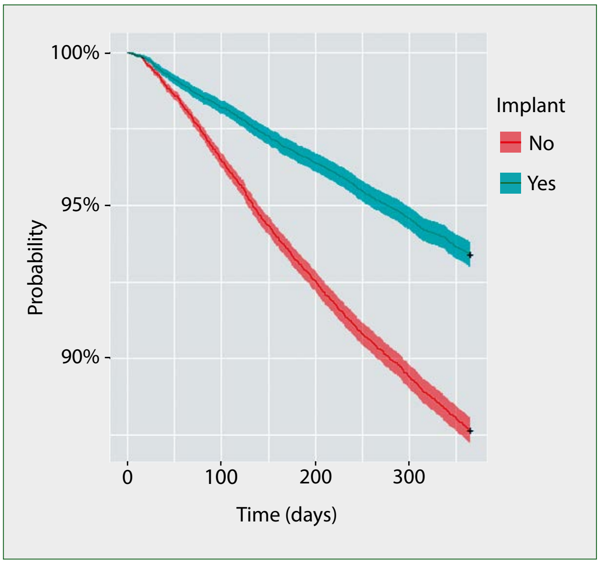

Figure 8. Kaplan-Meier curve showing changes in probability of no reoperation as number of days since hospital discharge increases, with and without use of implants

urban areas, OR = 0.864), surgery with an implant compared to surgery without an implant (OR = 0.817, Fig. 8), the performance of the primary surgery in a neurosurgical department (OR = 0.724) compared to other departments) and 1–2-day, 3-day, 4–7-day or > 7-day hospital stays compared to a one-day surgery (OR = 0.343, 0.19, 0.172, and 0.209, respectively). A detailed analysis of one-day surgeries, which is the reference group for the variables reporting other hospital stays, showed that out of 4,382 operations in this group, 4,324 (98.7%) were assessed according to DRG code H55 (arthroscopic and percutaneous spine procedures).

Discussion

Our results show there is a relationship between the demographic and clinical variables selected for the purposes of this study and the risk of reoperation within 365 days of hospital discharge after primary surgery for DSD. The reoperation rate for all 38,953 observations was 10.12%. When analysing the distribution of comorbidity variables, it can be observed that the reoperation rate ranged from 3.16% to 21.13% (Tab. 1). Based on observations obtained from hospital discharges in Washington state (USA) for the period 1997–2007, Martin et al. estimated the reoperation rate for the period of one year after lumbar disc herniation surgery (one of the most common surgeries performed on the spine) to be 6.4% (range 2.8% to 12.5%). The risk of reoperation was higher in women and in patients with multimorbidity [19].

The logistic regression analysis provided several interesting and practically important observations. There were variables that increased, as well as others that decreased, the risk of reoperation. The variables that were associated with a statistically significant increase in the risk of reoperation included:

Demographic variables

Older age is one of the strongest predictors of reoperation; this is especially true for patients aged 70-79 (OR = 1.225). Park et al., in their study concerning the risk of reoperation for lumbar spondylosis after spinal decompression surgery using different methods of spinal instrumentation (implants), found an association between reoperation and older age / male sex [20]. In contrast, Pereira et al. [21], in their 24-month study, found no association between older age and the risk of reoperation in patients with lumbar DSD. However, the risk of reoperation increased significantly with the extent of surgery (the risk was higher for operations involving more than three spinal segments) [21]. With age, there is an increase in the number of health problems and in the sensitivity of the body to adverse effects of external factors, while there is at the same time a decrease in the adaptive capacity of the body and the capacity of individual organs and systems. In view of the increasing proportion of elderly patients receiving surgical treatment for DSD worldwide, we can expect to see an increasing number of adverse events, including reoperations in facilities providing healthcare for these patients. Surgical treatment for DSD in elderly patients provides an opportunity for many of them to relieve pain, return to daily activities and regain independence. Reduction of adverse events in elderly patients undergoing surgery is favoured by an optimal rebalancing of their health status before the planned operation – operating on patients classified as 1 or 2 on the ASA scale [21].

Clinical variables according to the Elixhauser classification

Depression was diagnosed in 1,673 patients in the study group, and 14.76% of them required reoperation within a year. This is a strong risk factor for reoperation, increasing its likelihood by more than 50%. Such a large increase in the risk of reoperation must be kept in mind when qualifying and preparing patients for surgery. Depression is one of the most important risk factors for persistent postoperative pain (PPS) in spinal surgery [22]. Studies have shown that preoperative depression is correlated with rates of complication, readmission and reoperation [23–26]. Boakye et al. distinguished not only confirmed depression, but also other groups of patients who use antidepressants for other reasons. In all groups, the reoperation rate was higher compared to patients without depression and not taking antidepressants (OR 1.4-2.03) [26]. Persistent pain, which negatively affects satisfaction with the outcome of the primary spinal surgery, may result in more frequent patient eligibility for reoperation. Studies demonstrate that independent of surgical effectiveness, baseline depression influences patient satisfaction after spinal surgery [27, 28]. The possibility of interplay between DSD and depression should be noted; it is thought that reduced physical fitness (frequently faced by DSD patients) can result in depression and other affective disorders [29]. Maintaining physical activity in older age can reduce the risk of depression and improve self-esteem [10]. Hence, proper treatment of depression can reduce its negative impact on the musculoskeletal system. On the other hand, effective treatment (including surgical) of DSD symptoms can reduce the incidence or severity of depression and improve quality of life. However, it should be underlined that it is not only an effective treatment which improves the mental condition of patients. Before the treatment itself, they should be properly prepared. The need for information about pain, disability and return to work are found to be factors associated with anxiety and depression in patients undergoing spinal surgery [30]. This group of patients requires a personalised approach and the utmost attention from medical personnel to obtain optimal results.

Obesity was found to be another strong risk factor for reoperation (OR = 1.401). It was diagnosed in 438 patients, and 15.11% of them were reoperated. The observed increase in risk has been confirmed in other studies [25, 30–32]. Goyal et al.'s meta-analysis of 32 studies involving 23,415 patients showed that in patients undergoing lumbar spine surgery, obesity increased the risk of complications (OR = 1.34) and reoperation (OR = 1.40). Minimally invasive surgery was not reported to have worse outcomes in obese patients [33]. The increased risk of postoperative complications, including surgical site infection and reoperation in obese patients, could be due to a higher level of surgical invasiveness, a longer duration of surgery, or higher intraoperative blood loss in obese patients [33, 34]. In the study by Gaudelli et al., the most common reason for reoperation of obese patients was surgical site infections [36]. In order to reduce the surgical risk, it is suggested to use minimally invasive techniques in obese patients [37]. In addition, these patients should be properly prepared for the procedure, and a multidisciplinary approach is essential in these cases.

An association between comorbidities (e.g. renal disease, severe liver disease, diabetes etc.) and recurrence rate after fusion surgery in DSD has been reported in studies based on Korean administrative data [37, 38].

Other variables

Patients operated on at a clinical centre had a higher likelihood of reoperation (OR = 1.101). This observation may be a result of both a higher degree of difficulty of primary surgeries performed at these centres and of the generally higher degree of 'complexity' of cases. It would be useful to compare the characteristics of patients treated in clinical centres to those treated in non-clinical ones, including the surgical techniques used.

The variables that were associated with a statistically significant decrease in the risk of reoperation included:

Demographic variables

The patient's place of residence was correlated with the risk of reoperation, which was lower for those living in rural areas (OR = 0.864). According to epidemiological data, there is no difference in terms of the prevalence of low back pain in urban and rural residents [3]. The variety of reoperation rates may be rooted in the availability of specialist services, and differences in terms of overall health status and socioeconomic conditions, including motivation to working life.

Other variables

Surgery with an implant was associated with a lower risk of reoperation compared to surgery without an implant (OR = 0.817). This result can be explained by the relatively short follow-up period of 365 days from the date of hospital discharge after the primary surgery. In long-term postoperative follow-up, the use of implants is generally associated with an increased rate of reoperation, contrary to the study presented here [39]. A systematic review conducted by Lang et al. showed similar reoperation rates for decompression alone or decompression plus fusion surgeries for degenerative lumbar diseases. The authors point out, however, that the most common cause of reoperation after spinal decompression surgery is disease of the same spinal segment, whereas reoperation after fusion surgery is most frequently caused by adjacent segment disease [40].

Surgical treatment performed in a neurosurgical department was associated with a lower risk of reoperation compared to surgical treatment performed in another department (OR = 0.724). The study by Seicean et al. found no differences in terms of postoperative complications and reoperation rate after spinal surgeries performed by neurosurgeons and orthopaedic surgeons; however, their follow-up period was only 30 days [41]. In this study, 27,921 (71.7%) patients were treated in the neurosurgical department and 8,324 (21.4%) in the orthopaedic department. It is difficult to clearly interpret the observed differences between the aforementioned departments. It is possible that the complexity of spinal disease, and thus the extent and scope of surgery for patients operated on in orthopaedic departments, is greater (coexisting scoliosis, multi-level spinal instability, etc.), which may be the reason for more frequent reoperations.

Length of hospital stay was a clear predictor of reoperation. The reference point for 1–2-day, 3-day, 4–7-day and > 7-day hospital stays was a one-day surgery, for which the reoperation rate was the highest. The high risk of reoperation in patients who underwent one-day surgery may be explained by the surgery profile. A detailed analysis of one-day surgery cases, which is the reference group for the variables reporting other hospital stays, showed that out of 4,382 operations in this group, 4,324 (98.7%) operations were assessed according to DRG code H55 (arthroscopic and percutaneous spine procedures). These include minimally invasive surgeries such as endoscopic discectomy, IDET, vertebroplasty and thermolesion of intervertebral joints. The reoperation rate in this group of patients may be linked to the limited or short-term effectiveness of surgical procedures. This is especially true in the case of thermolesion or IDET, the main purpose of which is symptomatic management of the pain associated with spinal disease, rather than treatment of the cause of the complaint. The risk of reoperation for > 24h hospitalisations is lower, with the lowest values for 4–7-day hospital stays (OR = 0.172) and the highest values for 1–2-day hospital stays (OR = 0.343).

Two recently published studies based on Korean administrative data provide a comprehensive analysis of the variables associated with the reoperation rate after spinal surgeries for DSD [37, 38]. These studies focused on the association between reoperation rate and anatomical site [37], and on analysing the role of the surgical approach adopted[38]. However, the cited research included exclusively patients who underwent fusion procedures, who accounted for a mere 38.6% of cases in our study.

Strengths and limitations

The presented study is the first large-scale study concerning reoperation after surgery for DSD in Poland. This is a nationwide survey; the data was obtained from central sources, from the only public payer in Poland i.e. the NHF. The analysis included data concerning all publicly funded medical services of patients during the one-year period preceding the primary surgical treatment, which increases the likelihood of identifying comorbidities.

This study has limitations. This is a retrospective study based on reported data rather than a review of medical records. It is possible that many factors (smoking, alcohol, obesity, etc.) are underestimated compared to prospective studies. Also, data regarding the surgeon's experience and specialisation was not accessible. Subclassifications in terms of the anatomical site (cervical spine, lumbar spine, etc.), the surgical approach (anterior *vs*. posterior) and the underlying spine pathology (spinal stenosis, instability, spinal disc herniation, etc.) was not taken into consideration, and the postoperative follow-up period wass 12 months.

Conclusions

Reoperations within the first year after surgical treatment for DSD are common. Identifying risk factors for reoperation, including those related to the presence of comorbidities and the phenomenon of multimorbidity, can be an important tool in reducing the reoperation rate. This is particularly true for chronic diseases where appropriate medical management may enable the patient to be optimally prepared for surgery. In patients with several strong risk factors for reoperation, it may be prudent to forgo surgical treatment.

The practical implications of our results are linked to the awareness of the need for reoperation in quite a high percentage of patients subjected to spinal surgery. This applies mainly to general practitioners who refer patients to specialists such as neurosurgeons, spinal surgeons, and orthopaedic surgeons. In particular, elderly candidates for spinal surgery and those with multiple comorbidities should be thoroughly informed about the risks.

We recommend planning prospective studies concerning risk factors for reoperation after spinal surgery with a longer follow-up period. Optimally, this task could be realised within the framework of the national spine surgery registry.

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