ORIGINAL ARTICLE

Postdischarge pneumonia after hip arthroplasty: a population-based study of 55 842 patients in Poland

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KEY WORDS

arthroplasty, hip, orthopedics, pneumonia

ABSTRACT

INTRODUCTION Alloplasty is one of the most frequently performed procedures, as it hugely improves the quality of life.

OBJECTIVES The purpose of this study was to determine the incidence, risk factors, and clinical implications of postdischarge pneumonia after hip endoprosthesis in Polish adults.

PATIENTS AND METHODS This retrospective study was conducted using the database of the National Health Fund (Narodowy Fundusz Zdrowia) containing data from 55 842 hip arthroplasties performed in 2017.

RESULTS Postdischarge pneumonia was identified in 371 patients and accounted for 26.6% of all postdischarge infections, with incidence rate of 0.7%. Multivariable analysis showed a significantly higher risk of pneumonia in patients aged 65 and older (odds ratio [OR], 3.5; 95% CI, 2.40–5.03), urgently admitted (OR, 4.0; 95% CI, 3.16–4.98), operated in winter (OR, 1.7; 95% CI, 1.37–2.11), and hospitalized in the intensive care unit (OR, 5.9; 95% CI, 3.65–9.46). Preventative factors were pre-surgery treatment for diseases of the musculoskeletal system (OR, 0.7; 95% CI, 0.59–0.91) and postoperative rehabilitation (both outpatient and inpatient; OR, 0.3; 95% CI, 0.10–0.99 and OR, 0.7; 95% CI, 0.42–0.99, respectively). Seventy patients (18.9% of pneumonia cases) required inpatient pneumonia treatment. The in-hospital case fatality rate observed in postdischarge pneumonia was 21.4%.

CONCLUSIONS Pneumonia is one of the most common postoperative infections after hip endoprosthesis, especially in winter, requiring rehospitalization. Efforts should be made to prepare patients in the perioperative period.

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INTRODUCTION Osteoarthritis is one of the 10 most disabling diseases in developed countries, affecting 10% of men and 18% of women over the age of 60.[1] Coxarthrosis, which increases the number of elective and urgent surgeries due to fractures, is the most common reason for a surgical intervention.[2] Indications for hip arthroplasty (HPRO) include fractures involving the femoral head, necrosis of the femoral head, fractures of the femoral neck, or complicated displaced acetabular fractures, which are especially important among the elderly. It is estimated that due to the aging of the population, the problem of hip fractures over the next 30 to 40 years will affect up to 7 million people annually.[3] Therefore, hip arthroplasty—the most effective method of improving the quality of life of patients, by reducing pain and allowing them to resume activity—belongs to the most frequently performed procedures. Every year, up to 300 hip arthroplasties per 100 000 people are performed in different countries. For example, in Germany there were 309 such procedures in 2017,[4] while in Poland there were only 160.

Unfortunately, as any surgical intervention, this procedure carries a risk of adverse effects.

WHAT'S NEW?

This is the first study to analyze the Polish population of patients undergoing arthroplasty in terms of health care–associated pneumonia. It identifies many factors that can be improved in the perioperative period, which can be of great benefit to patients. It also emphasizes the necessary modification of patient preparation procedures through the implementation of appropriate vaccinations and rehabilitation, and focuses on patients discharged with antibiotics as those with an increased risk of infectious complications. The study suggests the need to introduce appropriate infection prevention and control with the elimination of risk factors at the hospital and postdischarge stages.

According to data from Canada, 8.1% of patients developed at least 1 in-hospital complication following the hip fracture surgery, while the overall complication rate after hip arthroplasty was 75% according to the data from Groningen (2009–2013); the most commonly reported complication was delirium, while the incidence of surgical complications was 9%.[5,6] Some complications are potentially preventable, one of them being pneumonia, the most serious and common health care–associated infections after HPRO. The incidence, taking into account both in-hospital and postdischarge cases, reaches 4%–5%, which is significantly higher than the incidence associated with surgical site infections. Additionally, patients with pneumonia after hip arthroplasty also have a higher risk of hospital readmission, bloodstream infection, and mortality.[7,8] The occurrence of pneumonia also significantly reduces health-related quality of life and extends the time of recovery to full activity, which correlates with etiological agents of infection.[9] In the case of viral pneumonia, this time is from 13 to 33 days, for bacterial pneumonia it is from 7 to 43 days, and for pneumonia of mixed etiology it is even 10 to 50 days.[9] A reduced health-related quality of life score was observed up to 18 months after the onset of the disease in a Danish study.[10]

Little is known regarding the occurrence of postdischarge pneumonia after hip fracture surgery. The purpose of this study is to determine the incidence, risk factors, and clinical implications of postdischarge pneumonia after hip replacement surgery in Polish adult patients.

PATIENTS AND METHODS

Study group The analysis was carried out on retrospective data collected by the Polish National Health Fund (Narodowy Fundusz Zdrowia [NFZ]) for 2017. NFZ databases—including data reported from orthopedic wards as patients' clinical registers, data on issued prescriptions, data on outpatient and hospital care financed from public funds—were extracted and anonymized by the NFZ employees to contain all data related to pneumonia (the amount of data was limited based on what information was recorded by the NFZ). The study group comprised only surgical procedures funded by the NFZ. Due to a lack of access to the private sector databases, those data were not included in our study. Out of 56 104 hip replacement procedures (coded according to the *International Classification of Diseases and Related Health Problems, 9th Revision* as 81.51–55, 00.7, and 00.8) performed in 2017, we excluded those performed in children (<18 years old; n = 36) and procedures that required extended hospital stay (over 30 days, due to the pneumonia temporal criteria; n = 226). Ultimately, 55 842 cases of hip replacement surgery were included in the present analysis.

Data analysis We analyzed demographic and clinical data involving the patients (age, place of residence, chronic comorbidities, number of drug groups prescribed before surgery), data on the immunization status (influenza vaccine) and rehabilitation prior to admission, and information on the conditions related to the procedure (type, primary vs secondary, length of hospital stay [LOS], stay in the intensive care unit [ICU]). Data concerning pneumonia following hospital discharge were collected on the basis of rehospitalizations and ambulatory visits, along with additional data on postdischarge rehabilitation, stay in a long-term facility, or in-home professional care (eg, a visiting nurse); a detailed description of the data provided is available in Supplementary material.

In this publication, we made the following assumptions to facilitate the grouping and statistical analysis of the existing data:

1 The patient's place of residence (urban or rural) was determined depending on whether it was located in an urban or rural municipality.

2 The burden of patients with particular disease entity at the preoperative stage was assessed based on medications prescribed within 1 year prior to the procedure. Multimorbidity was defined as the use of medications from at least 2 different groups according to the Anatomical Therapeutic Chemical (ATC) Classification Codes, provided that the medications were only available on prescription (relevant data available in Supplementary material).

3 Taking medications from 5 or more ATC-code groups served as a criterion for polytherapy, provided that these medications were available on prescription.

4 Rehabilitation was considered preoperative if it took place up to 90 days prior to the surgery, provided that it was a reimbursed service.

5 The variables were categorized into groups based on the age of the patients (<65 years vs ≥65 years) according to the age on the day of the procedure.

6 A diagnosis of pneumonia (*International Classification of Diseases and Related Health Problems, 10th Revision*: J13.*, J15.*, J16.*, and J18.8) was made in an outpatient facility or during readmission to a hospital: Health care Evaluated Data (HED) or hospitalization.

7 Index hospitalization was defined as the hospitalization with the surgery.

TABLE 1 Characteristics of the analyzed population including the incidence of pneumonia (up to 30-day follow-up)

Characteristics of the study group		Total (n = 55 842)	Pneumonia incidence rate	*P* value
Sex	Female	32 446 (58.1)	245 (0.8)	0.002
	Male	23 396 (41.9)	126 (0.5)	
Age	<65 y	19 780 (35.4)	34 (0.2)	<0.001
	≥65 y	36 062 (64.6)	337 (0.9)	
Hematological diseases	No	42 191 (75.6)	256 (0.6)	0.003
	Yes	13 651 (24.4)	115 (0.8)	
Cardiovascular diseases	No	18 075 (32.4)	84 (0.5)	<0.001
	Yes	37 767 (67.6)	287 (0.8)	
Musculoskeletal diseases	No	22 861 (40.9)	194 (0.8)	<0.001
	Yes	32 981 (59.1)	177 (0.5)	
Neurological diseases	No	29 510 (52.8)	177 (0.6)	0.047
	Yes	26 332 (47.2)	194 (0.7)	
Respiratory diseases	No	47 459 (85.0)	288 (0.6)	<0.001
	Yes	8383 (15.0)	83 (1.0)	
Rehabilitation before surgery	No	53 041 (95.0)	363 (0.7)	0.01
	Yes	2801 (5.0)	8 (0.3)	
Type of admission	Planned	40 606 (72.9)	124 (0.3)	<0.001
	Urgent	15 091 (27.1)	244 (1.6)	
Intensive care unit stay during index hospitalization	No	55 488 (99.4)	350 (0.6)	<0.001
	Yes	354 (0.6)	21 (5.9)	
Antibiotics on discharge	No	53 498 (95.8)	345 (0.6)	0.007
	Yes	2344 (4.2)	26 (1.1)	
Long-term care	No	54 825 (98.8)	358 (0.6)	0.001[a]
	Yes	646 (1.2)	9 (2.0)	
Rehabilitation after discharge	No	48 314 (86.5)	345 (0.7)	0.001
	Outpatient	1699 (3.0)	3 (0.2)	
	Inpatient	5829 (10.4)	23 (0.4)	

Data are shown as number (percentage) of patients.

a Fisher exact test

The temporal qualification criterion, within 30 days of the surgery, was adopted according to the American College of Surgeons National Surgical Quality Improvement Program.[7]

Statistical analysis The incidence of postdischarge pneumonia after hip replacement procedures was calculated with respect to the characteristics of the patient as well as of the procedure. The comparison between the groups was based on the χ^2 test or the Fisher exact test for variables with a very small number of observations. The risk of pneumonia was assessed in a multivariable logistic regression model. In the final model, only factors significant in the univariable analysis were included. In addition, we decided not to include influenza vaccines because of highly limited number of cases and their correlation with both surgery performed during winter and antibiotics on discharge. All analyses were performed using International Business Machines Corporation Statistical Package for the Social Sciences, version 26 (IBM Corporation, Armonk, New York, United States). For all analyses, the significance level was set up at $P < 0.05$.

Ethics This work was approved by the Bioethics Committee of the Jagiellonian University, Kraków (1072.6120.149.2020). The study was based on data gathered during routine patient care and the analysis did not include any individual participant data.

RESULTS In 2017, 55 842 HPROs were performed and 371 pneumonia cases were detected postdischarge, with an incidence rate of 0.7%.

Pneumonia affected significantly more often women and patients aged 65 and older. The pneumonia incidence was significantly higher in patients with chronic diseases of the respiratory, nervous, and circulatory systems, and lower in the group of people treated for diseases of the musculoskeletal system before the surgery (TABLE 1). Polytherapy, found in 52.2% of the patients, did not affect the risk of pneumonia. Influenza vaccination was reported in only 280 people out of all the operated patients, which constituted 0.5% of our study population and had no significant effect on the risk of pneumonia ($P = 0.708$).

The risk of pneumonia was significantly increased by an emergency procedure (1.6% vs 0.3%, $P < 0.001$), and the need to stay in the ICU during the first hospitalization (5.9% vs 0.6%, $P < 0.001$). ICU stay was the greatest risk factor of pneumonia in this study. The length of index hospitalization of patients with post-discharge pneumonia (median, 6 days; interquartile range [IQR], 5–8 days) was significantly longer than in the patients without the infection (median, 6 days; IQR, 4–7 days) ($P < 0.001$).

A total of 2370 patients (4.2%) were treated with antibiotics upon discharge from the hospital following their index hospitalization, and they were diagnosed with pneumonia significantly more often (1.1% vs 0.6%; $P = 0.007$).

In the patients who underwent pre- or postoperative rehabilitation, the incidence rate of pneumonia was significantly lower, but the patients admitted to long-term care facilities in the postsurgery period had significantly higher pneumonia incidence rate. Multivariable analysis showed a significantly higher pneumonia risk in elderly patients (odds ratio [OR], 3.5; 95% CI, 2.40–5.03; $P < 0.001$) suffering from diseases of the respiratory and nervous systems before the surgery (OR, 1.5; 95% CI, 1.15–1.90; $P = 0.002$ and OR, 1.3; 95% CI, 1.01–1.56; $P = 0.038$, respectively), admitted urgently (OR, 4.0; 95% CI, 3.16–4.98; $P < 0.001$), in patients operated during winter (OR, 1.7; 95% CI, 1.37–2.11; $P < 0.001$), and hospitalized in the ICU (OR, 5.9; 95% CI, 3.65–9.46; $P < 0.001$).

The factors that significantly reduced the incidence of pneumonia were treatment for the diseases of the musculoskeletal system before the surgery (OR, 0.7; 95% CI, 0.59–0.91;

TABLE 2 Multivariable analysis of risk factors for pneumonia up to 30 days after hospitalization

Characteristics of the study group		OR	95% CI	*P* value
Sex (male)		1.06	0.85–1.32	0.63
Age (≥65 y)		3.47	2.40–5.03	<0.001
Hematological diseases		1.15	0.91–1.44	0.25
Cardiovascular diseases		1.16	0.90–1.50	0.26
Musculoskeletal diseases		0.73	0.59–0.91	0.005
Neurological diseases		1.26	1.01–1.56	0.04
Respiratory diseases		1.48	1.15–1.90	0.002
Rehabilitation before surgery		0.56	0.28–1.13	0.11
Admission type (urgent)		3.97	3.16–4.98	<0.001
Winter season		1.70	1.37–2.11	<0.001
Intensive care unit		5.88	3.65–9.46	<0.001
Long-term care		1.23	0.70–2.18	0.47
Rehabilitation after hospitalization	No (reference)	1.00	–	–
	Outpatient	0.32	0.10–0.99	0.048
	Inpatient	0.65	0.42–0.99	0.047

Abbreviations: OR, odds ratio

P = 0.005) and postoperative outpatient or inpatient rehabilitation (OR, 0.3; 95% CI, 0.10–0.989; *P* = 0.048 and OR, 0.7; 95% CI, 0.42–0.99; *P* = 0.047, respectively) (TABLE 2).

In the study group, 70 patients (18.9%) required in-hospital pneumonia treatment, of which 15 died, implying an in-hospital fatal case rate in the studied pneumonias of 21.4%.

DISCUSSION The results presented in this study indicate the significance of both demographics, that is, factors that directly burden the patient (eg, age over 65) and selected elements of pre- and perioperative care, especially the type of admission and rehabilitation.

The sex of the patients was not a significant risk factor, as confirmed in the literature.[11] Individual authors often obtain contradictory results that may stem not from biological differences in patients aged over 65 years (eg, hormonal cycles and cellular immune-mediated responses), but rather from cultural, behavioral and socio-economic differences, which could be significant determinants of the course and outcome of pneumonia.[11]

An unexpected result was that polytherapy had no effect on pneumonia incidence, despite the fact that it is considered one of the most significant exposure factors.[12,13] This could be related to the very high level of total polytherapy in the study population, which affected more than half of the analyzed cohort, while Brazilian studies displayed a prevalence of polypharmacy at 27.5%,[14] a Swiss university in primary care settings at 37.0%,[15] and a Qatar-based study displayed its prevalence at 75%.[16] On the other hand, in the analyzed population, most of the procedures were planned. Preoperative treatment, mainly cardiovascular, was therefore most likely optimized so that the patients could qualify for the surgery, increasing the likelihood of polytherapy that did not have a negative impact on complications. Treatment of musculoskeletal diseases prior to the surgery in our population was a protective factor against the risk of pneumonia. There are reports that treatment of osteoporosis reduces the risk of death.[17] Moreover, vitamin D supplementation significantly reduced the incidence of recurrent episodes of pneumonia in a study by Yang et al.[18]

Vaccines are a simple and cost-effective tool for preventing infectious diseases. However, there was no evidence of a protective effect of the influenza vaccination in the study population, which was of significant concern to the authors. Other large population studies confirm the effectiveness of influenza vaccination in the prevention of pneumonia, especially in combination with pneumococcal vaccinations.[19,20] The WHO recommends that 75% of the elderly people should be vaccinated against seasonal influenza. In 2017, the average vaccination rate against influenza among the elderly population aged 65 and over was 42% in OECD countries, with the highest percentages in Korea at 83% and the UK at 73%, while the following rates were observed in the former Soviet Bloc countries: 5% in Estonia, 7% in Latvia, and 12% in Slovakia.[21] Unfortunately, the OECD report does not include the data on vaccination rates in Poland, where neither the influenza nor pneumococcal vaccinations are mandatory for adults and are not widely used, as confirmed by the present results. Therefore, such low levels of vaccination against influenza (0.5%) most likely do not reduce the risk of pneumonia in the perioperative period. On the other hand, data from Danish ICUs from 2005 to 2015 indicate that, in severely ill patients, confirmed by the need for hospitalization in the ICU, there is no reduction in the risk of pneumonia following the influenza vaccination.[22]

A very strong protective factor in the study population was postoperative rehabilitation, which, depending on the setting (inpatient vs outpatient), reduced the risk of pneumonia by 2 and 3 times, respectively. Other authors report similar effects.[23,24] Unfortunately, no analogous outcomes were found for preoperative rehabilitation, although in other types of procedures, such as cardiac surgery[25] or upper abdominal surgery,[26] this kind of preparation was demonstrated to be effective in the prevention of pneumonia. A likely explanation of our results could be once again the small size of the group, in which only about 5% of the study population received such a benefit, resulting in no demonstrable protective effect in the postprocedural pneumonia prevention.

The analyzed data included only postdischarge pneumonia, for which, according to Danish data gathered within 30 days of the surgery, the all-infections rate for in-hospital treatment was 12.8%,[27] while in Korea, the in-hospital pneumonia incidence rate was 11.1%.[28] Unfortunately, there is a lack of data from predischarge

surveillance, which is rarely carried out in Poland, and the data are neither mandatory nor widely reported. There are known data on the incidence rate of surgical site infections (SSI) after HPRO in Polish hospitals, from 1.5% to 5.8%, but there are no data on in-hospital or postdischarge pneumonia in orthopedic patients.[29,30] However, even the incidence rate of SSI reported by Polish authors (1.5% or more for SSI) exceeds the mean values (1.0% for HPRO and 0.5% for knee arthroplasty) presented in ECDC reports for European countries.[29-31] Moreover, the dominant proportion of deep infections in Polish analyses suggests poor detection of superficial SSIs after knee arthroplasty.[29,30] Thus, the results of this analysis seem to confirm the hypothesis of low sensitivity of the infection surveillance, including collecting, analyzing, and sharing such data in Polish hospitals, because in the analyzed group of 55 842 patients, as many as 4.2% received antibiotics upon discharge. Currently, however, none of the known recommendations for perioperative management indicates the need for antibiotics in such cases.

Due to the fact that the patients discharged with an antibiotic prescription were more often rehospitalized than those without the prescription (1.1% vs 0.6%), special caution is required prior to discharging people from their index hospitalization. For the aging population, a comprehensive geriatric evaluation is recommended, along with the development of infection prevention and control. Therefore, we have determined that other authors rightly noticed the problem of efficacious implementation of effective infection prevention and control tools in the so-called "care bundle"[32] in the prevention of infections in Polish hospitals, as well as problems related to microbiological diagnostics of health care–associated infections.[33,34] This is of particular importance in the aging, often rehospitalized population.

The pneumonia incidence rate in the analyzed group at the level of 0.7% is about 5 times higher than the 0.13% incidence rate reported for hospital pneumonias in surgical departments and 3 times higher than the 0.2% incidence rate in nonsurgical departments in a 5-year single-center study in a Polish hospital.[32] Tichopad et al[33] evaluated the burden of community-acquired pneumonia (CAP) among adults in the Czech Republic, Hungary, Poland, and Slovakia and found rates of CAP of 0.32% (41 918 out of 13 281 964) and 0.44% (22 938 out of 5 184 564) among people aged between 50 and 64 years and over 65, respectively. Taking into account the average rate of (expected) CAP at 0.35% and the fact that the number of visits would probably be greater than the number of patients, the incidence of pneumonia in our group of patients is over 2 times higher than in the general population.

Although the median LOS was almost identical among patients with and without the infection, the hospitalization of the patients with pneumonia was significantly longer with the difference most visible in the last quartile: 7 or 8 days. Arefian et al[34] noticed that infections, especially those associated with medical care, significantly extended the LOS by an average of more than 8 additional days. Polish data emphasize that the time from admission to the surgery is a significant risk factor of mortality and longer hospital stay. Moreover, since 2010 there has been a decrease in the percent of surgery in 2 days from admission.[35] Unfortunately, a limitation of that study is the lack of complete data on pneumonia diagnosed during the index hospitalization.

This retrospective study had some limitations. First of all, we do not know the results of predischarge pneumonia surveillance at the analyzed hospitals, whenever such surveillance was in place. Demographic information for the study population was limited; thus, data on the complete characteristics of surgical procedures as well as information regarding differences in the type of care received by the patients, were unavailable. On the other hand, a strong point of the study is the method of data collection, which guaranteed that they were comprehensive.

In conclusion, in the course of the postoperative period following hip arthroplasty, the incidence of pneumonia is high in the Polish population, especially among elderly patients.

Postoperative rehabilitation, in both in- and outpatient settings reduces the risk of pneumonia. Due to the influence of seasonality on the occurrence of pneumonia in the postoperative period, in the case of procedures planned for the fall and winter, it is strongly recommended to vaccinate against pneumococci and influenza in the preoperative period. The best solution would be to perform the surgery on elderly patients in the spring or summer.

Due to the significant risk of rehospitalization among patients taking antibiotics after discharge, it is recommended to conduct a careful evaluation of patients. For an aging population, a complete geriatric evaluation is the recommended solution.

The present results indicate an urgent need for effective and widespread implementation of infection prevention and control bundles, and an effective multicenter infection surveillance program in Polish hospitals, including systematic collection, analysis and sharing of data on serious infections, not only concerning SSIs but also pneumonia. Poland lacks a broad, uniform, continuous, widely used reporting system for health care–associated infections.

SUPPLEMENTARY MATERIAL

Supplementary mateial is available at www.mp.pl/paim.

ARTICLE INFORMATION

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CONTRIBUTION STATEMENT MG, AP, BG, AR, and JW-M conceived the concept of the study, and the design of the research. AP, MG, and PG analyzed the data. JW-M coordinated the project. MG and IP prepared the manuscript draft. All authors edited and approved the final version of the manuscript.

CONFLICT OF INTEREST None declared.

DATA AVAILABILITY The data underlying this article will be shared on reasonable request to the corresponding author.

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