




## Article

# Predictive Factors of Inpatient Rehabilitation Stay and Post-Discharge Burden of Care After Joint Replacement for Hip and Knee Osteoarthritis: A Retrospective Study on 1678 Patients

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**Abstract:** The global demand for end-stage hip and knee osteoarthritis surgical treatment is rising, as is the need of optimal postoperative rehabilitation. Patient stratification is key to provide rehabilitation professionals and policy makers with real-life data in support of early discharge planning and continuous care provision. The aim of this retrospective, observational study was to investigate which factors can predict the burden of care at discharge (BCD) and the inpatient rehabilitation length of stay (LOS) based on a set of demographic, societal, clinical and organizational data collected from a high-volume orthopedic hospital. We included 45,306 variables from 1678 patients. All variables were initially tested individually using a linear regression model for inpatient rehabilitation LOS and a logistic regression model for BCD. Variables that resulted significant ( $p < 0.05$ ) were subsequently considered in a single, comprehensive linear regression model, or a single, logistic regression model, respectively. Age, living with a family, occupational status, baseline Barthel Index and duration of surgery were predictors of inpatient rehabilitation LOS and BCD. Sex, primary or secondary osteoarthritis, American Society of Anesthesiologists score, body mass index, transfusion, biological risk, type of anesthesia, day of surgery, numeric pain rating scale and baseline cognitive function at baseline were not. Including specific patient comorbidities, surgical access technique and chronic use of pharmacological therapy can improve the predictive power of the model.

**Keywords:** aging; continuity of care; inpatients; rehabilitation; osteoarthritis; arthroplasty; population health management



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## 1. Introduction

The prevalence of osteoarthritis is expected to increase globally due to aging populations, obesity, and increasing injury rates [1–4]. Joint diseases accounted for more than half of all chronic conditions in patients aged 60 years and more during “The Bone and Joint Decade” (2000–2010) [5]. In 2019, about 528 million people worldwide were living with osteoarthritis, an increase of about 113% since 1990 [6,7].

By making movement painful and difficult, osteoarthritis can impair working, socializing, and performing the basic activities of daily living (ADL), causing mental health problems such as depression, sleep disorders, and difficulties in relating [1,8–10]. Also, the burden of care reversed on caregivers should be considered, bearing in mind that they may be aged and/or frail. An estimated 344 million people living with osteoarthritis experience severity levels that could benefit from rehabilitation [11].

The latest stage of the disease is commonly treated with joint replacement surgery, especially in the case of hip and knee osteoarthritis [1]. While the general demand for total joint arthroplasty is expected to increase up to 673% by 2030 [12–14], the knee is the most affected joint worldwide [15], with total hip arthroplasties rising quickly [16,17]. Postoperative rehabilitation programs vary significantly in terms of functional outcomes, accessibility, and costs, basically depending on the setting (e.g., home, inpatient, outpatient) and degree of institutional integration (funding policies and continuity between hospitals, intermediate, and primary care units) [16,18]. In the case of home rehabilitation, relevant costs may fall directly on patients, potentially leading to health inequalities and socially determined disabilities. Therefore, effective rehabilitation and efficient care organization are crucial to improve functioning (personal value) and reduce the societal impact of disease (societal value) [19,20].

Patient stratification, population health management, and out-of-hospital care enhancement are strongly supported to preserve sustainability in overloaded healthcare systems, especially in aging regions and after the COVID-19 pandemic [21,22]. By estimating the inpatient rehabilitation length of stay (LOS) and the burden of care at discharge (BCD) in advance, discharge planning could be initiated earlier, institutional follow-up organized, and patients and caregivers better prepared for a safe hospital discharge. Standardized, real-life information from high volumes of patients is crucial to this purpose.

The aim of this study is to investigate which factors can predict the burden of care at discharge (BCD, in estimated hours) and inpatient rehabilitation length of stay (LOS, in days) based on a set of demographic, social, clinical, and organizational data collected from the clinical records of a high-volume orthopedic hospital, before surgery, after surgery, before rehabilitation, and after rehabilitation.

These factors can help policymakers improve continuity of care and help healthcare professionals initiate optimal post-discharge solutions on time.

## 2. Materials and Methods

This is a retrospective observational study based on a population of patients admitted for surgery and consecutive inpatient rehabilitation at IRCCS Ospedale Galeazzi-Sant' Ambrogio in Milan, Region of Lombardy, Italy. The hospital specializes in treating musculoskeletal conditions and is accredited with the National Health Service (NHS) and the Italian Ministry of Health for both clinical and research activity. In 2024, the hospital was awarded for treating the highest number of patients coming from other regions of the country, either privately (out-of-pocket) or funded by the NHS.

Electronic hospital datasets were employed to identify adult patients who underwent total hip replacement (THR) or total knee replacement (TKR) to treat primary or secondary osteoarthritis and were directly discharged to inpatient rehabilitation in the same facility. Patients were tracked through internal, anonymous codes. The diagnoses and procedures of interest were identified based on the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9CM).

All the adults who underwent surgery and subsequent inpatient rehabilitation in 2019 were selected as a study population, as they represented the largest population sample before the COVID-19 pandemic, during which the hospital had to rearrange the wards to face the emergency [23]. Then, the hospital moved to a bigger facility in late 2022. We found 1710 patients eligible for the study.

The principal investigator (FP) and a physical therapist (VT) performed the data collection. The choice of including only patients discharged to inpatient rehabilitation in the same facility was due to the high number of standardized information present in the rehabilitation clinical record, part of which is mandatory to receive reimbursement by the NHS. BCD is an estimation of the assistance needed by the patient at home, depending on his/her degree of autonomy at discharge. Patients discharged elsewhere were excluded as it was impossible to collect rehabilitation data.

Among the standard variables available, those deemed to have potential predictive value were selected by expert opinion. Common variables that intuitively can have an impact on joint replacement surgery, rehabilitation outcomes, and duration are age, sex, comorbidities, body mass index (BMI), intraoperative characteristics, blood loss, cognitive function, and functional autonomy before rehabilitation. The American Society of Anesthesiologists (ASA) score was adopted as a proxy of patient comorbidity, along with biological risk to healthcare workers, as blood-borne pathogens are a risk in major orthopedic procedures [24,25], and the impact on postoperative complications and recovery is controversial [26–29]. The day of surgery was collected to evaluate whether there was an organizational impact on the length of rehabilitation stay. Patient profession, living arrangements, and BCD were collected to investigate possible correlations between social determinants of health and intrahospital rehabilitation outcomes. In addition to standardized information, patient verticalization after surgery was collected from hand-written notes reported in the clinical diary of each surgical record to evaluate a possible impact on the length of rehabilitation stay (e.g., the earlier verticalization, the better and faster recovery or the opposite).

The variables were selected by the principal investigator [FP] supported by the Scientific Director [GB], two physiatrists with clinical and research expertise [SN, CK], the chief physician [CP], and the chief physical therapist [DG] of the inpatient rehabilitation unit. A physical therapist with statistical expertise helped the principal investigator define the final selection [CC]. After removing incomplete records, 1678 patients were included in the study (Table 1).

**Table 1.** Inclusion and exclusion criteria.

Inclusion Criteria
<ul style="list-style-type: none"> <li>• Age ≥ 18 years.</li> <li>• ICD-9CM diagnostic codes 715.15, 715.16, 715.25, 715.26 (primary and secondary hip or knee osteoarthritis).</li> <li>• ICD-9CM procedural codes 81.51, 81.54 (THR or TKR).</li> <li>• Patients directly discharged to inpatient rehabilitation from the surgical ward in the same facility.</li> </ul>
Exclusion Criteria
<ul style="list-style-type: none"> <li>• Patients discharged elsewhere than the same facility rehabilitation ward.</li> <li>• Patients characterized by incomplete records.</li> </ul>

Finally, a dataset including 27 variables for each patient was elaborated. The dataset was collected in an Excel sheet and anonymized (Table 2).

**Table 2.** Dataset.

Administrative Database	Clinical Record—Surgery	Clinical Record—Rehabilitation
(Patient internal identifier). (Clinical record numbers). Age at admission (number). Sex (male or female). Profession (more standard options). ASA score.	Main diagnosis (ICD-9CM). Main surgical procedure (ICD-9CM). BMI before surgery.	Patient-reported pain at admission (numeric rating scale). Hemoglobin at admission (g/Dl) <sup>1</sup> . Barthel Index, total score at admission (0–100). Cognitive function at admission: memory domain (0–7), relations domain (0–7), problem-solving domain (0–7).
Duration of surgical intervention (minutes). Type of anesthesia (more options). Biological risk to healthcare workers (seropositive patient) (yes/no). Blood transfusion (yes/no). Day of surgery (Monday–Saturday).	Patient verticalization (number of days after surgery). Surgical ward length of stay (LOS) (days).	Living arrangement (more standard options). Inpatient rehabilitation LOS (days). Barthel Index, total score at discharge (0–100). Cognitive function at discharge, three domains (0–7 each). Burden of care at discharge (more standard options, in hours).

<sup>1</sup> Grams per deciliter.

Statistical analyses were performed by a researcher [CC] to define which factors could predict the inpatient rehabilitation LOS and BCD, both aggregated (THR and TKR) and disaggregated (THR or TKR). Descriptive statistics are presented as medians and interquartile ranges or absolute values, percentages, and frequencies based on the nature of each variable. These data are reported narratively. Inpatient rehabilitation LOS was measured in days (from day 0, the day of discharge from the surgical ward, to the last day, the day of discharge from the inpatient rehabilitation ward). BCD was divided into multiple clusters of hours, according to the standardization adopted in the rehabilitation clinical health record: no hours of care needed, up to three hours of care needed per day, up to six hours of care needed per day, and twenty-four hours of care needed per day. To conduct the logistic regression, the dependent variable “burden of care at discharge” was dichotomized (no assistance, assistance). All variables were initially tested individually using a linear regression model for inpatient rehabilitation LOS and a logistic regression model for BCD. Variables found to be significant ( $p < 0.05$ ) were subsequently in a single, comprehensive linear regression model for inpatient rehabilitation LOS or a single logistic regression model for BCD.

### 3. Results

In total, 45,306 data were manually collected from 1678 patients.

The majority of patients were 65 years old or older (1184, 69%), females (1071, 63%), and the majority of procedures were TKR (1086, 64%). Over a total of 1086 TKR procedures, the majority were performed for primary knee osteoarthritis (1071, 99%). Over a total of 624 THR procedures, the majority were performed for primary hip osteoarthritis (595, 95%). Female patients were more affected by both knee and hip osteoarthritis, representing about 66% of the knee population (720 over 1086, including primary and secondary osteoarthritis) and 56% of the hip population (351 over 624, including primary and secondary osteoarthritis).

#### 3.1. Predictors of Inpatient Rehabilitation LOS

##### 3.1.1. THR (Table 3)

For patients undergoing THR, several factors significantly influenced inpatient rehabilitation LOS. These factors include age, surgical duration, living arrangements, and hemoglobin levels upon admission to rehabilitation. Specifically, older age and longer surgical duration are associated with extended rehabilitation LOS. Additionally, patients residing with individuals other than family members tend to experience longer rehabilitation LOS. On the contrary, higher hemoglobin levels at the time of rehabilitation admission are linked to a shorter LOS. In general, a coefficient of determination equal to 0.21 suggests that factors other than those included in the model significantly influence inpatient rehabilitation LOS.

**Table 3.** Predictors of inpatient rehabilitation LOS after THR.

Coefficient of Determination	Variables	Beta	p-Value
R <sup>2</sup> = 0.21	Secondary hip osteoarthritis	0.02	0.63
	<b>Age</b>	0.23	<0.001
	Sex	0.04	0.28
	<b>Surgical time</b>	0.30	<0.001
	Surgical ward LOS	0.01	0.87
	General anesthesia	−0.001	0.98
	Transfusion	0.05	0.24
	Barthel Index at admission	−0.08	0.70
	Living arrangement (alone)	0.06	0.74
	Living arrangement (family)	0.01	0.96
	<b>Living arrangement (other)</b>	0.09	<b>0.03</b>
	Pain at admission	−0.05	0.17
	<b>Hemoglobin</b>	−0.09	<b>0.03</b>
	Verticalization time	0.06	0.15

### 3.1.2. TKR (Table 4)

For patients undergoing TKR, several factors significantly impact inpatient rehabilitation LOS. These include age, surgical duration, the Barthel Index score at admission, hemoglobin levels at admission, and the timing of verticalization after surgery. Specifically, older patients tend to have a longer rehabilitation LOS. Similarly, longer surgical procedures correlate with extended LOS, albeit with a lesser effect than THR. A higher Barthel Index score at the time of admission is also associated with an increased LOS. Conversely, higher hemoglobin levels at admission and earlier verticalization post-surgery are linked to a shorter rehabilitation LOS. In general, a coefficient of determination equal to 0.25 suggests that other factors than those included in the model significantly influence inpatient rehabilitation LOS.

**Table 4.** Predictors of inpatient rehabilitation LOS after TKR.

Coefficient of Determination	Variables	Beta	p Value
R <sup>2</sup> = 0.25	<b>Age</b>	0.19	<b>0.02</b>
	Sex	0.03	0.39
	Occupational status	0.02	0.58
	<b>Surgical time</b>	0.05	<b>&lt;0.001</b>
	Surgical ward LOS	0.31	0.11
	General anesthesia	0.01	0.83
	Biological risk	−0.01	0.75
	Transfusion	0.02	0.51
	<b>Barthel Index at admission</b>	0.10	<b>&lt;0.001</b>
	Living arrangement (alone)	−0.09	0.39
	Living arrangement (family)	−0.16	0.11
	<b>Hemoglobin</b>	−0.11	<b>&lt;0.001</b>
	<b>Verticalization time</b>	0.11	<b>0.001</b>

### 3.1.3. Total Population (Table 5)

When considering the population as a whole, the following factors significantly predict the inpatient rehabilitation LOS: age, occupational status, surgical duration, living arrangements, hemoglobin levels at admission, and the timing of verticalization post-surgery. Older age is associated with a longer rehabilitation LOS, while unemployed and retired patients also tend to have a slightly longer LOS. Although a longer surgical duration generally leads to an extended LOS, its impact is less pronounced than THR alone. Patients living with family members typically experience a shorter LOS. Additionally, higher hemoglobin levels at rehabilitation admission and earlier verticalization after surgery are linked to reduced inpatient rehabilitation LOS. In general, a coefficient of determination equal to 0.24 suggests that factors other than those included in the model significantly influence inpatient rehabilitation LOS.

**Table 5.** Predictors of inpatient rehabilitation LOS after THR and TKR aggregated.

Coefficient of Determination	Variables	Beta	p Value
R <sup>2</sup> = 0.24	Primary hip osteoarthritis	−0.09	0.79
	Secondary hip osteoarthritis	−0.01	0.95
	Primary knee osteoarthritis	0.06	0.62
	Total hip arthroplasty	0.14	0.55
	Total knee arthroplasty	−0.13	0.74
	<b>Age</b>	<b>0.22</b>	<b>&lt;0.001</b>
	Sex	0.03	0.18
	<b>Occupational status</b>	<b>0.05</b>	<b>0.05</b>
	<b>Surgical time</b>	<b>0.04</b>	<b>&lt;0.001</b>
	Surgical ward LOS	0.33	0.12
	Subarachnoid anesthesia	−0.14	0.31
	Bier block anesthesia	−0.07	0.17
	General anesthesia	−0.12	0.33
	Biological risk	0.0	0.99
	Blood transfusion	0.03	0.21
	Living arrangement (alone)	−0.12	0.15
	<b>Living arrangement (family)</b>	<b>−0.19</b>	<b>0.02</b>
	<b>Hemoglobin</b>	<b>−0.10</b>	<b>&lt;0.001</b>
	<b>Verticalization time</b>	<b>0.09</b>	<b>&lt;0.001</b>

### 3.2. Predictors of the Burden of Care at Discharge

#### 3.2.1. THR (Table 6)

For patients undergoing THR, occupational status, surgical ward LOS, and Barthel Index at inpatient rehabilitation admission were significant predictors of BCD. Unemployed or retired patients are 84% more likely to require additional hours of care after discharge compared to those who are employed. Additionally, for each extra day in the surgical LOS, the likelihood of needing more hours decreases by 15%. Similarly, for each additional point in the Barthel Index score at the time of inpatient rehabilitation admission, the likelihood of requiring more hours of care after discharge was reduced by 4%. In general, a coefficient of determination equal to 0.13 suggests that other factors than those included in the model significantly influence the burden of care at discharge.

**Table 6.** Predictors of BCD after THR.

Coefficient of Determination	Variables	Beta	p Value
R <sup>2</sup> = 0.13	Age	0.99	0.64
	Sex	0.76	0.23
	<b>Occupational status</b>	<b>1.84</b>	<b>0.03</b>
	<b>Surgical ward LOS</b>	<b>0.85</b>	<b>0.02</b>
	<b>Barthel Index at admission</b>	<b>0.96</b>	<b>0.002</b>
	Verticalization time	0.71	0.06
	Barthel Index at discharge	0.97	0.27

#### 3.2.2. TKR (Table 7)

In the case of TKR, surgical LOS and Barthel Index at inpatient rehabilitation admission and verticalization time after surgery were significant predictors of BCD. For each additional day in the surgical LOS, the likelihood of requiring more hours of care decreased by 15%. For each extra day that a patient achieves verticalization after surgery, the need for additional care hours decreases by 33%. Moreover, for each additional point in the Barthel Index score at the time of inpatient rehabilitation admission, the likelihood of needing more post-discharge care hours is reduced by 4%. In general, a coefficient of determination equal to 0.20 suggests that other factors than those included in the model significantly influence the burden of care at discharge.

**Table 7.** Predictors of BCD after TKR.

Coefficient of Determination	Variables	Beta	p Value
R <sup>2</sup> = 0.20	Occupational status	1.29	0.11
	Surgical time	1.01	0.08
	<b>Surgical ward LOS</b>	<b>0.88</b>	<b>&lt;0.001</b>
	<b>Barthel Index at admission</b>	<b>0.96</b>	<b>&lt;0.001</b>
	<b>Verticalization time</b>	<b>0.67</b>	<b>0.005</b>
	Barthel Index at discharge	0.95	0.07
	Occupational status	1.29	0.11

#### 3.2.3. Total Population (Table 8)

When considering the population as a whole, occupational status, surgical duration, Barthel Index at inpatient rehabilitation admission, verticalization time after surgery, and Barthel Index at discharge were significant predictors of BCD. Unemployed or retired patients are 33% more likely to require additional hours of care after discharge than those employed. For each additional minute of surgical intervention, the possibility of needing more hours of care at discharge diminishes the likelihood of needing more care hours at discharge by 16%. Interestingly, for every extra day a patient achieves verticalization after surgery, the need for additional care hours is reduced by 36%. Additionally, for each extra

point in the Barthel Index score at inpatient rehabilitation admission, the likelihood of requiring more post-discharge care hours decreases by 4%. Similarly, every additional point in the Barthel Index score at inpatient rehabilitation discharge leads to a 5% reduction in the likelihood of needing more care hours after discharge. In general, a coefficient of determination equal to 0.16 suggests that other factors than those included in the model significantly influence the burden of care at discharge.

**Table 8.** Predictors of BCD after THR and TKR aggregated.

Coefficient of Determination	Variables	Beta	p Value
R <sup>2</sup> = 0.16	Primary hip osteoarthritis	0.93	0.88
	Primary knee osteoarthritis	0.66	0.47
	Total hip arthroplasty	0.75	0.82
	Total knee arthroplasty	1.72	0.68
	<b>Occupational status</b>	<b>1.33</b>	<b>0.03</b>
	<b>Surgical time</b>	<b>0.84</b>	<b>&lt;0.001</b>
	Surgical ward LOS	1.00	0.54
	<b>Barthel Index at admission</b>	<b>0.96</b>	<b>&lt;0.001</b>
	<b>Verticalization time</b>	<b>0.64</b>	<b>&lt;0.001</b>
	<b>Barthel Index at discharge</b>	<b>0.95</b>	<b>0.02</b>

#### 4. Discussion

Many recent studies highlight the ongoing relevance of predictive factors in inpatient rehabilitation, particularly following joint replacement surgery. These works emphasize the importance of understanding how demographic, clinical, and procedural variables impact rehabilitation outcomes and post-discharge care. Our investigation aligns with this growing body of literature, addressing a critically relevant topic in contemporary rehabilitation research [30–32].

The findings from our large population, single-year monocentric investigation, identify several variables that predict inpatient rehabilitation LOS and BCD. In addition, the study highlights variables that were not predictive and potentially excludes predictors that warrant further investigation in further research.

The correlation between aging and osteoarthritis, widely recognized in the literature, is confirmed by the present investigation. This study also confirms that knee osteoarthritis affects women (66%) more than men, whereas this sex difference still exists but tends to diminish when considering hip osteoarthritis, with women accounting for 56% of the cases [33]. Degenerative causes overwhelmingly account for both knee and hip osteoarthritis, far surpassing traumatic and other causes, as 99% of TKRs were performed for primary osteoarthritis, while 95% of THRs were performed for secondary osteoarthritis.

In our patient population, age was predictive of a longer inpatient rehabilitation both after hip and knee replacement, while sex was not. Neither age nor sex predicted a higher BCD for both conditions. Primary and secondary hip or knee osteoarthritis were not predictive of a longer inpatient rehabilitation or of a higher BCD.

Early patient mobilization is associated with reduced postoperative complications such as blood clots [34–36], accelerated functional recovery [37], and improved patient-reported outcomes, at least in the short term [38]. Caution is recommended in verticalizing old and/or frail patients too early [37]. This research confirms the benefits of early patient mobilization, possibly extending this finding to elderly patients, considering that they represent the vast majority (about 69%) of the population. However, since most of these patients were admitted to surgery with a moderate ASA score in our study population, prudence remains recommended for patients at higher clinical risk.

Patients living with family members tend to have a shorter inpatient rehabilitation LOS, possibly due to their readiness for a safe discharge compared to those having other living arrangements, such as living alone or with non-family members. This is in line with previous observations suggesting that inpatient rehabilitation outcomes are influenced by

levels of social support [39–41]. Unemployed and retired patients have slightly longer inpatient rehabilitation LOS. On the one side, this correlation may be explained by their older age, which would be the real predictor of a longer stay. Conversely, working patients may have more urgency to recover and return to work, possibly motivating more engagement. Similar findings were reported by Adogwa and collaborators (2017) in people undergoing spine surgery, supporting the hypothesis that employed participants could have a greater desire to return to their social and professional activities and may be more likely to adhere to postoperative treatment interventions [42].

ASA score, BMI, transfusion, biological risk, type of anesthesia, day of surgery, pain levels at inpatient rehabilitation admission, cognitive function domains at inpatient rehabilitation admission, and discharge were not significant predictors of BCD and inpatient rehabilitation LOS. Interestingly, this is also confirmed by recent studies reporting that variables such as ASA score and obesity do not negatively predict clinical recovery after surgery when included in multivariate analyses [43,44]. Moreover, in our sample, these latter variables might not be informative since high-complexity patients are not generally recommended to undergo major surgery, resulting in a very homogenous study population.

A higher Barthel Index score at admission was predictive of a reduced BCD. This outcome can be attributed to greater functional autonomy observed before discharge and even earlier, at the point of inpatient rehabilitation admission following discharge from the surgical ward. Such interpretation supports the beneficial impact of prehabilitation on THR and TKR [45,46], which the present population did not undergo. However, a higher Barthel Index score at admission also correlated with longer inpatient rehabilitation LOS after TKR, which needs further investigation. Longer surgical interventions predicted fewer hours of care needed at discharge, both after THR and TKR. These observations might be associated with clinical characteristics not detected in the present study. Therefore, they need to be further investigated.

In general, the  $R^2$  coefficient in all cases suggests that other factors may be predictive of inpatient rehabilitation LOS. Therefore our findings need to be balanced against other possible predictors excluded in the current model. We hypothesize that patient comorbidities, surgical access technique, and chronic use of pharmacological therapy might significantly contribute to this gap, presenting an opportunity for further research.

This study presents additional limitations.

- I. Manual data collection from paper-scan medical records limited the study population to a single year (the year in which most eligible patients were admitted). Electronic health records linking patients across different units could help include more patients treated in previous years by collecting information more easily and systematically. Our hospital is gradually implementing electronic health records in all departments. Moreover, this study represents a preliminary part of a larger European research on the use of artificial intelligence to develop predictive models in rehabilitation (PREPARE Rehab) [47]. Therefore, the predictive value of the current model can be strengthened in the next years. Meanwhile, 45,306 datapoints from 1678 patients represent a relevant dataset both in numbers and type of data, including standardized social and organizational information not commonly investigated. If rehabilitation is a multimodal, person-centered, collaborative process [48], this information is useful for regional or local health policies integrating the multiple silos of care and reducing service fragmentation based on comprehensive patient needs [19,21,23,49]. Intermediate care, primary care, home care, reablement, and restorative care services can benefit from real-world population health management, including social care for elderly patients [50–54], and even more considering that patients undergoing rehabilitation in the same facility could be precisely the most demanding patients in terms of clinical and social characteristics (e.g., age, comorbidities, living too far from the hospital to receive outpatient follow-up, having problems in receiving home assistance).
- II. The ASA score is an index of patient comorbidity developed for surgical purposes and not specifically for rehabilitation. The systematic adoption of electronic clinical

records will help (a) retrieve more detailed information on comorbidities easily and (b) design and perform prospective observational studies on a similar patient population for number and data diversity. In general, the expected impact of electronic health records is to facilitate the collection, analysis, and comparison of epidemiological, clinical, and policy datasets from high volumes of patients, different facilities, regions, and countries. More sophisticated methods, such as machine learning, offer further room for value to this purpose [55]. Accurate data protection (e.g., anonymization or pseudonymization) approaches also need to be considered. This research adopted a data pseudonymization approach in order to protect the privacy of patients while also allowing a patient-centered collection and analysis. Moreover, to reply and make such investigations applicable in different contexts, especially predictive models, external validation is mandatory [56]. External validation is planned on our cohort of patients before the model is proposed for clinical use.

- III. The standardization of intrahospital procedures and outcome scales can make the results hard to generalize outside Italy, as different countries, healthcare systems, and institutions (e.g., healthcare insurance or NHS) are likely to make different data collection mandatory for reimbursement.

However, the information presented here pertains to an aging population of patients, which is globally relevant in terms of epidemiological, societal, and financial pressure, regardless of how specifically we measure that pressure. Moreover, our data will be federally shared on the Observational Medical Outcomes Partnership (OMOP) Common Data Model (CDM) [57]. Therefore, such fine-grade provision of real-world, heterogeneous data can support the global collection of scarcely reported information (like social and organizational data), add new labels to the epidemiological vocabulary, uniform the use of procedures and outcome scales, and pave the way for similar investigations from other research centers.

## 5. Conclusions

Hip and knee osteoarthritis is a leading cause of pain and disability in the aging population worldwide. The collection of standardized demographic, clinical, societal, and organizational data from a high-volume orthopedic hospital provides valuable insights on postoperative rehabilitation for epidemiological, clinical, and policy use.

Our research confirmed the predictive value of age and sex in terms of disease exposition; found the occurrence of primary osteoarthritis to overwhelm the occurrence of secondary osteoarthritis; and found age, living with family, occupational status, baseline Barthel Index score, and surgery duration predictive of inpatient rehabilitation LOS and/or BCD. Two predictive factors need further investigation. Other variables need to be included to increase the predictive strength of this model, including application in other contexts. Investigating specific comorbidities, surgical access techniques, and chronic use of pharmacological therapy can fill this gap. The systematic implementation of electronic health records linking patient treatments performed by different care units is recommended to facilitate research both at a local and global level, further advanced by advanced machine learning methods.

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**Informed Consent Statement:** Due to the retrospective nature of the study conducted at an IRCCS, in agreement with art. 110—bis, Legislative Decree 196/2003 that states “the processing of personal data collected for clinical activity, for research purposes, by IRCCS does not constitute further processing by third parties”, no further informed consent was obtained. However, the information about the protection of personal data was disseminated by public proclamation via the Institute’s website.

**Data Availability Statement:** Data available in a publicly accessible repository: <https://zenodo.org/records/14005800>, accessed on 18 December 2024.

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