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Effects of the elixhauser comorbidity index on the time of discharge and 30-day mortality rate in geriatric and non-geriatric patients undergoing partial hip prosthesis arthroplasty

Ozkan Gorgulu[1], Sadullah Turhan[2]

[1]Antalya Training and Research Hospital, Depatment of Anesthesiology and Reanimation, Antalya, Turkey
[2]Antalya Training and Research Hospital, Orthopedics and Traumatology, Antalya, Turkey

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Abstract

In this study, we aimed to analyse the non-routine discharge period of the ECI and its predicted effect on the 30-day mortality rate in geriatric and non-geriatric patients admitted for partial hip replacement. 215 patients who underwent elective partial hip arthroplasty under spinal anaesthesia in our tertiary hospital were included in the study. This was a single-centre retrospective descriptive study. Data were collected by reviewing the electronic patient data system and patient files. The patients were divided into two groups as non-geriatric (18-64-year-old, n=125) and geriatric (≥65-year-old, n=90). The impact of the Elixhauser Comorbidity Index (ECI) on postoperative mortality rates and the discharge time from the hospital was analysed by comparing the age groups. The ECI percentage values (80.86 ± 3.99) of recovered patients were higher than patients discharged as exitus (71.5 ± 7.74) (p <0.001). While Elixhauser comorbidity index was negatively related to mortality (odds ratio, OR:0.711; 95% CI: 0.543-0.931; p=0.013), transfer to postoperative intensive care was positively related with mortality (OR:40.078; 95% CI: 3.694-434.822; p=0.002).There was no significant difference in mortality with respect to age groups and gender (p> 0.05). When ECI≤77.8%, it predicts mortality with 77.8% sensitivity and 85.92% specificity. The Elixhauser Comorbidity index could not predict the time of discharge due to complications developed after transfer of patients to the postoperative intensive care unit. There was no significant correlation between ECI and discharge time in non-geriatric and geriatric patients.

Keywords: Anaesthesia; comorbidity; geriatrics; non-geriatric; hip prosthesis; mortality

Introduction

Non-geriatric patients can be defined as persons between the ages of 18–64, while patients 65 years old and over are classified as geriatric. In this group, the effects of aging resulting from demineralization include large bone fractures, hip fractures and general weakening of the musculoskeletal system and other body systems. Multimorbidity, which is the simultaneous existence of two or more chronic diseases in a patient, has become widespread due to aging populations [1]. Morbidity increases with age. Overall, it affects 67% of the society with a prevalence of 50% in those under 65 years old, 62% in those aged between 65–74 years and 81.5% in those over 85 years old [1].

*Corresponding Author: Ozkan Gorgulu, Antalya Training and Research Hospital, Department of Anesthesiology and Reanimation, Antalya, Turkey
E-mail: drozkangorgulu@hotmail.com

Comorbidities in geriatric patients increase the morbidity and mortality rates after hip arthroplasty. Comorbidity indices are used to represent one or more comorbidities by a score determined by applying comorbidity questionnaires [2]. Two of the most frequently used comorbidity indices are the Charlson Comorbidity Index (CCI) and the Elixhauser comorbidity index (ECI) developed by Walravel et al.

The ECI score is derived from the weighted sum of comorbidities and can be used to predict the length of hospital stay and the risk of mortality [3]. In the literature, high numerical values [4] and low percentage scores were observed in the ECI of elderly patients undergoing total knee arthroplasty and developing postoperative ileus. The ECI has been shown to be an accurate mortality predictor, with an accuracy of 73.3% [5]. The ECI has been shown to have a 60% better performance than the CCI index in predicting mortality [6]. Both comorbidity models have shown similar performance in predicting the length of hospital stay in non-routine patients [6]. In addition, they are useful for predicting in-patient care costs [7].

Based on this, in this study, we aimed to analyze the non-routine discharge period of the ECI and its predicted effect on the 30-day mortality rate in geriatric and non-geriatric patients admitted for partial hip replacement.

Materials and Methods

Patient population

This study was conducted from 2010 to 2018 in accordance with the Helsinki Declaration. The data were obtained by retrospectively scanning the files of patients who underwent partial hip arthroplasty under spinal anesthesia in a single-center between 2010 and 2018. Ethics committee approval was received from the Antalya Training and Research Hospital Ethics Committee (Approval Date / Protocol No: 09.01.2020- 1/10). In this study, the data of 243 patients were analyzed. Since the data of 28 patients were not available, they were excluded from the study. This study was conducted by examining the electronic data from our system (SARUS) belonging to 215 patients treated in the orthopedics and traumatology clinic of our tertiary district hospital. The study was carried out as a retrospective file scan. Patients operated between 2010 and 2018 were included.

Assessment

A total of 215 patients who underwent elective partial hip arthroplasty under spinal anesthesia were included. The patients were separated into two groups as non-geriatric (aged from 18 to 64 years) and geriatric (aged 65 and over). The data were obtained by scanning the electronic patient data system (SARUS) and patient files. The ECI score percentages for the patients were calculated to determine the predicted effect of the comorbidities on the clinical results. The ECI ranges from 82.4% (range -19 point, least likely in-hospital death) to 0% (range 89 point, most likely in-hospital death) and the effect and percentage of the comorbidities on their own are as follows:

Elixhauser Comorbidity Index Score

Comorbidity Values and percentage rate

1. Congestive heart failure 7 points or 75.9%
2. Cardiac arrhythmias 5 points or 77.8%
3. Valvular disease -1 points or 83.3%
4. Pulmonary circulation disorders 4 points or 78.7%
5. Peripheral vascular disorders 2 points or 80.6%
6. Hypertension 0 points or 82.4%
7. Paralysis 7 points or 75.9%
8. Neurodegenerative disorders 6 points or 76.9%
9. Chronic pulmonary disease 3 points or 79.6%
10. Diabetes 0 points or 82.4%
11. Hypothyroidism 0 points or 82.4%
12. Renal failure 5 points or 77.8%
13. Liver disease 11 points or 72.2%
14. Peptic ulcer disease, no bleeding 0 points or 82.4%
15. AIDS/HIV 0 points or 82.4%
16. Lymphoma 9 points or 74.1%
17. Metastatic cancer 12 points or 71.3%
18. Solid tumor without metastasis 4 points or 78.7%
19. Rheumatoid arthritis/collagen vascular diseases 0 points or 82.4%
20. Coagulopathy 3 points or 79.6%
21. Obesity -4 points or 86.1%
22. Weight loss 6 points or 76.9%
23. Fluid and electrolyte disorders 5 points or 77.8%
24. Blood loss anemia -2 points or 84.3%
25. Deficiency anemia -2 points or 84.3%
26. Alcohol abuse 0 points or 82.4%
27. Drug abuse -7 points or 88.9%
28. Psychosis 0 points or 82.4%
29. Depression -3 points or 85.2%

The predictive accuracy of the ECI regarding discharge period and mortality was analyzed in geriatric and non-geriatric patient groups undergoing elective partial hip prosthesis operation.

Anesthesia

In the operating room, electrocardiography (ECG), peripheral oxygen saturation (SpO_2) monitoring, non-invasive blood pressure monitoring (NIBP) and invasive blood pressure monitoring were performed in patients with high cardiovascular risk. After recording the basal parameters and preloading with 10 mL kg^{-1} of crystalloid solution, 3 ml 0.5% hyperbaric bupivacaine (intrathecal, L3–L4 intervertebral space) was administered in the sitting position. All patients with sensory blockade (T10 level) were evaluated.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY). The normality assumptions were controlled using the Shapiro–Wilk test. Quantitative data were represented using mean ± SD (range) or n (%), where appropriate. Categorical data were analyzed using the Pearson chi-square and the Fisher's Exact tests. The differences between two groups were evaluated with Student's t-test for normally distributed data or Mann-Whitney U test for non-normally distributed data. The Spearman correlation coefficient was applied to investigate the correlation between Elixhauser comorbidity index and discharge time. Multivariate logistic regression analysis was used to determine independent risk factors associated with the 30 day mortality. The variables with $p<0.02$ in the univariate analyses were further run through multivariate logistic regression analysis. The receiver operating characteristic (ROC) curve analysis was applied to evaluate the predictive performance of the Elixhauser sensitivity and specificity were calculated and reported with 95% confidence intervals. The optimal cut-off point for measurements was determined as the value of the maximum Youden index. Values of p less than 0.05 were considered statistically significant.

Power Analysis

The study was conducted in a tertiary level hospital between 2010 and 2018 and included patients who were operated under spinal anesthesia (n=215). A posthoc power analysis using the Gpower 3.1 revealed a 99.1% statistical power with 0.05 alpha and d=1.52. It indicated that our study was powered adequately to demonstrate significant differences in the Elixhauser Comorbidity Index (%) according to mortality [8].

Results

The study participants were divided into two groups as 125 (58.1%) non-geriatric (<65 years) patients and 90 (41.9%) geriatric (≥65 years) patients. The non-geriatric group consisted of 59 (47.2%) males and 66 (52.8%) females and the geriatric group consisted of 35 (38.9%) males and 55 (61.1%) females (p = 0.226). In total, 43.7% of the study group were males (n=102). The mean age of the patients was 60.08 ± 15.58 years, the mean age of the non-geriatric patients was 49.5 ± 10.2 years and the mean age of the geriatric patients was 74.8±7.9 years (p< 0.001). When the groups were examined in terms of the distribution of ASA (American Society of Anesthesiology) scores, ASA 1 score percentage in the non-geriatric group (55.2%) compared to geriatric group (25.6%) was higher, and ASA 3 score percentage in the geriatric group (30%) compared to the non-geriatric group (9.6%) was higher (p <0.001). It was observed that the ECI values were higher in the non-geriatric group compared to the geriatric group (p < 0.001). No significant difference was observed in terms of anesthesia duration, operation duration, intraoperative crystalloid infusion values, discharge time, Perioperative Erythrocyte Transfusion frequency and Units of Perioperative Erythrocyte Transfusion values in geriatric and non-geriatric patients (p> 0.05). The percentage of transfer to intensive care units in the geriatric group (11.1%) was higher than the non-geriatric group (2.4%) (p = 0.008) (Table 1).

It was observed that the average age of patients discharged as exitus is higher than that of recovered patients (p = 0.008). There was no significant difference in mortality with respect to age groups and gender (p> 0.05). While the ASA scores were higher in the mortality group (p = 0.015), the percentage of patients with an ASA score between 3 and 4 was significantly higher in the mortality group (p = 0.003). The ECI percentage values (80.86 ± 3.99) of recovered patients were higher than patients discharged as exitus (71.5 ± 7.74) (p <0.001). No significant difference was observed in terms of anesthesia duration, operation duration, intraoperative crystalloid infusion values, discharge time, Perioperative Erythrocyte Transfusion frequency, and Units of Perioperative Erythrocyte Transfusion values in recovered and patients discharged as exitus (p> 0.05). In mortality group, the percentage of transfer to intensive care units (55.6%) was higher than the living group (3.9%) (p <0.001) (Table 2).

Table 1. Demographic and clinical characteristics of the patients

Variables	18-64-year-old Non-geriatric (n=125)	≥65-year-old Geriatric (n=90)	p
Age (years)	49.5±10.2(25-64)	74.8±7.9(65-98)	<0.001
Gender			
Male	66(52.8)	55(61.1)	0.226
Female	59(47.2)	35(38.9)	
ASA SCORE	1(1-4)	2(1-4)	<0.001
1	69(55.2)[a]	23(25.6)[b]	<0.001
2	41(32.8)[a]	37(41.1)[a]	
3	12(9.6)[a]	27(30)[b]	
4	3(2.4)[a]	3(3.3)[a]	
Elixhauser comorbidity index (%)	81.75±2.34(68.5-86.1)	78.7±6.12(55.6-82.4)	<0.001
Duration of anesthesia (minutes)	114.88±34.61(60-220)	109±33.32(60-270)	0.202
Duration of surgery	113.28±33.31(60-210)	107±32.58(60-270)	0.123
Intraoperative crystalloid infusion (ml)	2060±640.1(1000-4000)	1866.7±512.76(1000-3000)	0.072
Discharge time (day)	11.59±4.41(4-23)	11.86±4.62(3-27)	0.685
Postoperative transfer unit			
Orthopedic clinic	122(97.6)	80(88.9)	0.008
Intensive care unit	3(2.4)	10(11.1)	
Perioperative Erythrocyte Transfusion			
No	87(69.6)	68(75.6)	0.337
Yes	38(30.4)	22(24.4)	
Units of Perioperative Erythrocyte Transfusion	2.05±1.04(1-5)	2.05±0.79(1-4)	0.722

Data are presented as mean±SD (range) and n (%). Student's t test, Mann-Whitney U test, Pearson chi-square test. Different lowercase letters in a row indicate statistically significant difference between groups.

Table 2. Comparison of patients' demographics and clinical features according to mortality

Variables	Survived (n=206)	Exitus(n=9)	p
Age (years)	59.41±15.3(25-94)	75.44±14.88(59-98)	0.008
18-64	122(59.2)	3(33.3)	0.170
≥65	84(40.8)	6(66.7)	
Gender			
Male	116(56.3)	5(55.6)	0.999
Female	90(43.7)	4(44.4)	
ASA SCORE	2(1-4)	3(1-4)	0.015
1-2	167(81.1)	3(33.3)	0.003
3-4	39(18.9)	6(66.7)	
Elixhauser comorbidity index (%)	80.86±3.99(55.6-86.1)	71.5±7.74(59.3-82.4)	<0.001
Duration of anesthesia (sec)	111.6±32.86(60-220)	131.11±55.33(80-270)	0.188
Duration of operation	109.85±31.68(60-210)	128.89±56.22(80-270)	0.259
Intraoperative crystalloid infusion (ml)	1980.6±600.5(1000-4000)	1944.4±527.1(1500-3000)	0.764
Discharge time (day)	11.7±4.5(3-27)	11.5±0.7(11-12)	0.900
Postoperative transfer unit			
Orthopedic clinic	122(97.6)	80(88.9)	0.008
Intensive care unit	3(2.4)	10(11.1)	
Postoperative transfer unit			
Orthopedic clinic	198(96.1)	4(44.4)	<0.001
Intensive care unit	8(3.9)	5(55.6)	
Perioperative Erythrocyte Transfusion			
No	150(72.8)	5(55.6)	0.269
Yes	56(27.2)	4(44.4)	
Units of Perioperative Erythrocyte Transfusion	2.09±0.96(1-5)	1.5±0.58(1-2)	0.253

Data are presented as median (range) and n (%). Mann-Whitney U test, Fisher's Exact test

As a result of the logistic regression analysis, the Elixhauser comorbidity index and transfer to postoperative intensive care were identified as high-risk factors for mortality. While Elixhauser comorbidity index was negatively related to mortality (odds ratio, OR:0.711; %95 CI: 0.543-0.931; p=0.013), transfer to postoperative intensive care was positively related with mortality (OR:40.078; %95 CI: 3.694-434.822; p=0.002). (Table 3).

Table 3. Multivariate logistic regression analysis for determining the factors associated with mortality

Variables	OR(95% CI)	p
Age ≥65	0.482(0.056-4.163)	0.507
ASA score >2	0.047(0.001-3.313)	0.159
Elixhauser comorbidity index (%)	0.711(0.543-0.931)	0.013
Duration of anesthesia (sec)	1.014(0.994-1.034)	0.165
Postoperative transfer unit		
Orthopedic clinic	1	-
Intensive care unit	40.078(3.694-434.822)	0.002

A ROC analysis of the Elixhauser comorbidity index for mortality is given in Figure 1. AUC value for Elixhauser comorbidity index was 0.841 (95% CI, 0.785-0.887, p<0.001). According to the maximum value of the Youden index, optimal cut-off value of the Elixhauser comorbidity index for mortality was ≤77.8 and sensitivity and specificity were 77.78% (95% CI, 40.0-97.2) and 85.92% (95% CI, 80.4-90.4), respectively (Figure 1).

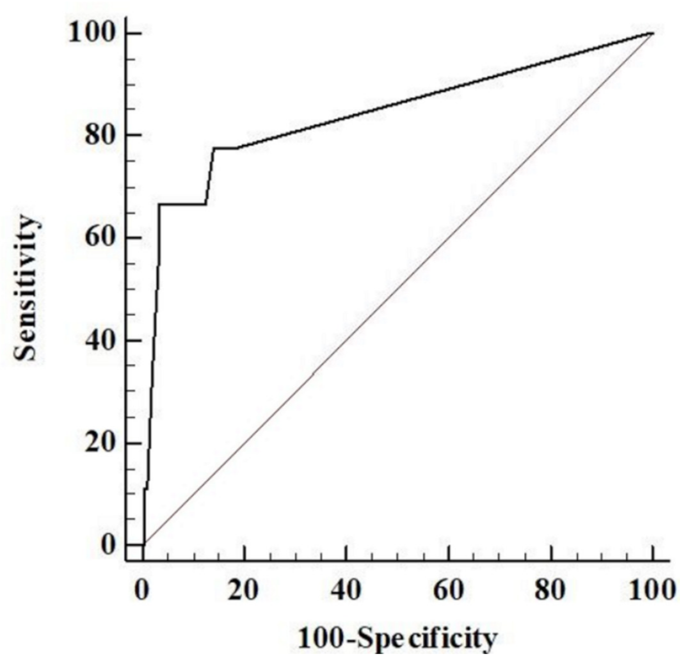

Figure 1. ROC curve for Elixhauser comorbidity index in the prediction of mortality

No significant correlation was found between the Elixhauser comorbidity index and the discharge time in non-geriatric and geriatric patients (p>0.05) (Figure 2).

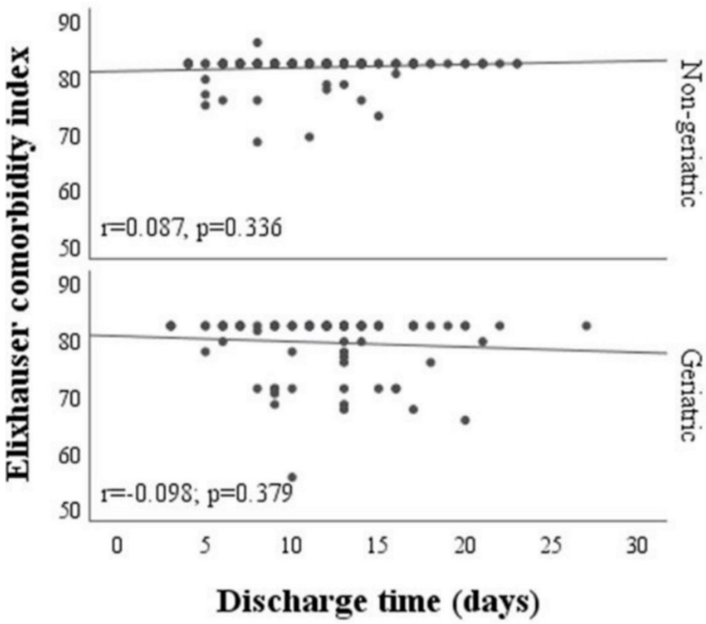

Figure 2. Correlation between Elixhauser comorbidity index and discharge time

Discussion

The presence of various comorbidity factors in elderly patients is known to increase postoperative complications, discharge time and mortality rate. A hundred and twenty-five (58.1%) of our patients were in the non-geriatric (<65 years) group and 90 (41.9%) were in the geriatric (≥65 years) age group. The mean age of the patients was 60.08 ± 15.58 years, the mean age non-geriatric patients was 49.5 ± 10.2 years and the mean age geriatric patients was 74.8 ± 7.9 years. The ECI values in the non-geriatric group (81.75 ± 2.34) were found to be higher than the geriatric group (78.7 ± 6.12). In our study, the mean discharge time was 11.59 ± 4.41 (days) in the non-geriatric group and 11.86 ± 4.62 (days) in the geriatric group. The Elixhauser Comorbidity Score is a good indicator evaluating discharge time and in-hospital mortality rate [9]. In a study involving 90.491 patients, the model containing all ECM comorbidity variables provided the best predictive model with 0.867 for mortality, 0.752 for extended stay, and 0.81 for non-routine discharge [10]. There are studies in the literature where in-hospital mortality and discharge time of ECI in patients with idiopathic pulmonary fibrosis were higher compared to the control group [11]. In our study, ECI was identified as an independent risk factor for mortality. However, although ECI made a good preoperative prediction for mortality, no significant correlation was found between ECI and discharge time. Although it is known in the literature that ECI is a parameter that provides a good estimation of both mortality and discharge time, the reason why it failed to predict discharge time in our study could be because of the extended hospitalization duration due to the complications developed in patients transferred to postoperative intensive care units. It is stated in the literature that Elixhauser and Charlson scoring methods give similar results in estimating mortality [12]. In contrast, the Elixhauser index contains more comorbidities than the Charlson index, which can provide better discrimination and prediction [13]. Logistic regression models were created to predict mortality control for age, gender and related comorbidity measurement, and overall suitability was evaluated using Nagelkerke's R Square criterion [13]. In our study, we applied the logistic regression model to investigate the risk factors affecting the length hospital stay of patients who underwent surgery under spinal anesthesia. As a result of the logistic regression analyses, the Elixhauser Comorbidity Index and transfer to postoperative intensive care units were identified as high-risk factors for mortality. While the ECI, was negatively related to mortality (odds ratio, OR:0.711; %95 CI: 0.543-0.931), transfer to postoperative intensive care units was positively related with mortality (OR:40.078; %95 CI: 3.694-434.822). Patients' being in a geriatric age group, having an ASA score above 2 or anesthesia duration has a limited effect on mortality. However, the increase in multimorbidities used in ECI calculation (percentage rate decrease) and the high mortality rate in patients transferred to postoperative intensive care was found to be closely related. When ECI≤77.8%, it predicts mortality with a 77.8% sensitivity and an 85.92% specificity. In contrast, a high ECI was found to be associated with a low percentage of index, longer hospital stay and increased mortality in the literature [14]. In the literature, there are studies reporting that gender, age range and seasonal differences have no effect on infection rates in total hip replacement operations [15]. Functional capacity in the geriatric patient population is lower compared to the adult age group, however, a rise in the rate of multimorbidity increases the mortality rate [1,16]. In a prospective cohort study, the significant correlation between physical functionality and mortality rate [12,17] supports our research. Elixhauser Comorbidity Index percentage rates were higher in patients under 65 years of age. This patient group mostly covers the group of ASA I-II patients, and it is the group with relatively few comorbidity factors. In contrast, when the ECI percentage ratios were lower, deviation values (6%) were higher in the group over 65 years of age, and ECI distributions change in a wider range. This group consists mostly of ASA III-IV patients and consists of patients with relatively higher comorbidity factors. In our study, although there was a significant difference between mean age 59.41 ± 15.3 (n=206) of recovered postoperative patients, and the mean age 75.44 ± 14.88 (n=9) of exitus patients; there was no significant difference in non-geriatric and geriatric age groups in terms of mortality. This result may be correlated with the small number of patients with postoperative exitus (n=9). Calculation of the ECI score during preoperative patient evaluation can be a guide for postoperative mortality rate and possible complications [18]. Although the ECI is a good indicator of mortality rate, it is insufficient in estimating the time of discharge. The single-center design and the small sample were the main limitations of our study. The ECI (%) is a useful scoring system for predicting patient mortality rates.

Conclusion

The ECI and transfer to postoperative intensive care units were significantly associated with a high risk for mortality. While the Elixhauser comorbidity index was negatively related to mortality, transfer to postoperative intensive care units was found to be positively related with mortality. When ECI≤77.8%, it predicts mortality with 77.8% sensitivity and 85.92% specificity. Elixhauser Comorbidity index could not predict discharge time due to complications developed in the geriatric patient group transferred to the postoperative intensive care unit. However, since the ECI was not correlated with discharge time, it was therefore not a good index for estimation of discharge time in patients undergoing hip arthroplasty.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
This study was conducted in accordance with the ethical principles stated in the "Declaration of Helsinki" and permission was obtained from Ethics Committee of Antalya Training and Research Hospital for the use of patient data for publication purposes (Approval Date/Protocol No: 09.01.2020-1/10).

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