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ORIGINAL PAPER

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The Charlson Comorbidity Index: predicting readmission and severity in emergency departments

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ABSTRACT

Introduction. The Charlson Comorbidity Index (CCI) is a comorbidity scale used widely throughout the world. Despite its widespread use, its relationship with patient readmission to the Emergency departments (ED) has not been evaluated previously.

Aim. To show whether there is a correlation between the CCI score and the number of repeated admissions to ED and that the CCI score can be used as a predicted factor for the serious patients.

Material and methods. This was a prospective observational cross-sectional study. Age, gender, vital signs of the patients who agreed to participate in the study was recorded. Numbers of ED readmissions of patients within six months after discharge and CCI scores have been recorded.

Results. The study was completed with 1420 patients. The admission rates of patients in the ED in the six months were significantly higher in the CCI 5+ group than in other groups ($p<0.05$) There was a positive correlation between the number of visits and CCI scores ($p<0.01$; $C>0$).

Conclusion. We believe that the CCI scoring system can be used by ED clinicians to predict the risk of readmission of patients after discharge from ED.

Keywords. Charlson Comorbidity Index, emergency medicine, readmission

Introduction

Emergency Departments (ED) intervene in and regulate the treatment of sudden illness or acute exacerbations of chronic illnesses.[1] In recent years, an increasing number of patients have been observed in emergency services around the world, and delays are being experienced in their treatment.[2-5] Patients who have been evaluated in the ED sometimes return with the same complaint shortly after being discharged, leading to the opinion that the initial evaluation and treatment they receive is inadequate.[6] These recurrent admissions increase the workload of the EDs, contribute to overcrowding, reduce the quality of treatment, and raise the healthcare costs. Similar to the global situation, the number of readmissions to the EDs in Turkey is increasing rapidly. This situation has created serious problems for the hospitals in our country. There are multiple reasons for readmission to the ED. Most of these are patient, disease, health, and clinician factors. However, few studies have revealed other reasons for repeated applications to the ED. Risk factors, demographic and clinical characteristics of patients must be assessed to identify groups at high risk of morbidity and mortality.[7,8]

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The Charlson Comorbidity Index (CCI) is a comorbidity scale used widely throughout the world.[9] It uses patients' preoperative and intraoperative morbidity factors to evaluate morbidity and mortality risk.[10] It includes 19 comorbidity factors: Acquired immuno-deficiency syndrome (AIDS), cancer, heart attack, heart failure, lymphoma, dementia, peptic ulcer, leukemia, metastasis, hemiplegia, benign liver diseases, connective tissue diseases, cerebrovascular disease, complicated diabetes, non-complicated diabetes, peripheral vascular disease, chronic respiratory diseases, moderate or advanced kidney failure, and moderate or severe liver disease. Morbidity and mortality estimates are given according to patients' CCI scores. Though the CCI has widespread use, it has not been evaluated in patients attending at EDs, and its relationship with patient readmission has not been shown previously.

Aim

In this study, we aimed to show whether there was a correlation between the CCI values and the number of ED readmissions of the patients during next six months period of our study. In addition, considering that CCI scoring is predictive for poor clinical outcome, we also aimed to examine the relationship between number of patients' readmissions and poor outcome indirectly.

Material and methods

Study design and setting

This was a prospective observational cross-sectional study carried out on patients admitted to the ED of Atatürk University Research Hospital in Turkey between 01.10.2018 and 07.04.2019. Our study was conducted in accordance with good clinical practice standards and was evaluated and approved by the Ethics Committee of the Faculty of Medicine before the study started (25.04.2018/Decision number: 4/Session number: 4). Informed consent was obtained from all patients prior to their registration.

Patient selection

Our study was conducted on patients admitted to the ED during a seven days period at the first phase of the study. Admitted patients were informed about the study, and those who agreed to participate were included to the study. In the second phase of the study, the number of readmissions to ED within the next six months of the patients included in the study during this 7-day period was examined.

Exclusion criteria

- Patients who did not agree to participate in the study
- Patients who were unable to provide informed consent (altered mental state, non-Turkish-speaking).
- Patients with non-hospital cardiopulmonary arrest
- Patients who had accessed ED for the same or a similar complaint within the last seven days.
- Patients younger than 18 years old.

Physicians involved in the study were given training on the research. Pre-prepared study forms were filled in via face-to-face interviews with participants. Emergency medicine specialists collected the data.

Measurements

Participants' age, gender, and vital signs (blood pressure, heart rate, body temperature and oxygen saturation) were recorded. In addition, the complaints that led to ED admission, the number of ED readmissions of the patients' during the next six months, and their CCI score were recorded. The patients were classified into four ordinal groups according their CCI scores; CCI 0, CCI 1–2, CCI 3–4, and CCI 5+ (5 points and above). Among these groups, having a high CCI risk score (CCI 3-4 and CCI 5+) was accepted as an indicator of poor clinical outcome. The relationship between this situation and the number of readmissions in the second phase of the study was examined.

Statistical analysis

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA). The percentages and frequencies for the categorical variables and the mean (± standard deviation [SD]) values for the continuous variables were determined. Nonparametric tests were used, as the data did not conform to a normal distribution. This included the Kruskall Wallis test for multiple groups with Bonferroni correction. A Chi-square test was used for categorical data analysis. A Spearman's correlation was used to test for a correlation between CCI risk groups. Mean ± SD values were used, and $p < 0.05$ was considered statistically significant.

Results

In total, 2111 patients attended our ED during the first phase of our. Of these, 354 did not agree to participate in the study. Those excluded from the study were listed; 15 patients with cardiopulmonary arrest, 116 patients with unconsciousness, 119 patients aged lower than 18 years old, and 87 patients with repeated ED visits (38 of these had repeat admissions during the first phase, while 49 had visited the ED before the study period). A total of 1420 patients who applied to the ED with different complaints were eligible for this study. Demographics, vital parameters and the most frequent complaints of all patients by CCI groups and the number of readmissions to the ED in the second phase of the study are shown in Table 1.

The differences between the patient groups created according to the CCI risk scores were examined. It was observed that those with a CCI score of 5 and above

were mostly male patients and male patients had higher CCI risk scores than female patients ($p<0.05$). There was also a difference between the groups in terms of the age of the patients. The mean age of the patients in the CCI 3–4 and CCI 5+ groups was significantly higher than the other groups ($p<0.05$). The number of patients who applied to the ED in the second phase of the study was significantly higher in the CCI 5+ group than in other groups ($p < 0.05$).

Finally, we evaluated the correlation between patients' CCI scores and their number of readmissions to the ED during the second phase. There was a positive correlation showing that as the number of readmissions in the second phase increased, so did CCI score ($p< 0.01$; $C>0$).

Discussion

One of the most important problems faced by physicians in the ED is to detect serious patients despite the intensity of their services. In this study, our aim was to examine the relationship between the clinical severity of patients and the rate of readmissions to the ED. We wanted to determine which patients were at high risk for discharge from ED. We used the CCI risk scoring system to explain this high-risk situation with an objective scale. We used a timeframe of six months to avoid the effects of cases involving renal colic and simple infection, which can cause repeated applications in a short period of time. The results of our study showed a statistically significant relationship between high CCI scores and readmissions within the six months period.

The 19 item CCI was first described by Charlson and colleagues in 1987 and has been modified many times.[11-13] It is used in 10-year mortality estimation in patients with multiple comorbidities; however, it has been studied in many areas. Several studies have been carried out to investigate the effects of comorbidity on postoperative complications. The effect of CCI score on complications after various surgical procedures has also been examined, and a large number of studies with extensive patient groups are available in the literature. For example, postoperative complication rates, hospitalization periods, and mortality rates were evaluated in patients who underwent surgery for pancreatic cancer.[14,15] In another study, there was a significant difference in the parameters mentioned in patients with a CCI score of 4 and above. Patients with CCI scores of 6 and above were three times more likely to die in 1 year than other patients.[16] Ather et al. found that mortality was significantly higher in nephrectomy patients who had CCI scores of 5 and above compared to other patients.[17]

According to previous studies, after discharge in stroke patients, CCI score was an indicator of prognosis. Each one point increase in CCI score was associated with a 15% increase in poor outcome at discharge, a 29% increase in one year mortality rate, and a 60% increase in 30 day mortality rate.[18-21] In our study, the rate of ED visits in the last 6 months was around two per patient (the maximum was 25), and the ED visit rate of patients with CCI scores of 5 and above was around sev-

Table 1. Demographics, vital signs, complaints and readmissions of the patients according to the charlson comorbidity ındex scores

	Charlson Comorbidity Index Groups				
	0	**1-2**	**3-4**	**5 plus**	p values*
Characteristics					
Male sex, n (%)	421 (56.9%)	139 (18.8%)	111 (14.9%)	70 (9.5%)	0.038
Age (years), mean	32.6 ±10.1	50.0±12.1	65.1±11.4	70.0±11.7*	<0.0001
Vital signs					
SBP (mmHg), median	121 (71-216)	129 (89-217)	130 (89-245)	130 (87-212)*	0.046
DBP (mmHg), median	79 (45-112)	80 (46-133)	80 (48-146)	75 (45-119)*	0.004
HR (beat/min), mean	87 ±12.8	85±12.6	86 ±14.5	89±17.2	0.125
O_2 Saturation (%), median	95 (60-100)	94 (72-100)	93 (60-99)	92 (60-98)*	<0.0001
Body temperature (°C), median	36.7 (36-39)	36.7 (36-40)	36.7 (36-38)	36.7 (36-39)	0.229
Complaints (most frequent)					
Trauma	142 (17.0%)*	32 (11.5%)	4 (2.1%)	6 (5.3%)	<0.0001
Chest pain	63 (7.6%)	8 (2.9%)	29 (14.9%)	18 (15.8%)*	0.001
Stomachache	92 (11.0%)	33 (11.9%)	18 (9.3%)	11 (9.6%)	0.803
Myalgia	84 (10.1%)	27 (9.7%)	16 (8.2%)	5 (4.4%)	0.244
Dyspnea	19 (2.3%)	7 (2.5%)	22 (11.3%)	19 (16.7%)*	<0.0001
Readmissions during 6 months	1.45 ± 2.27	2.30 ± 3.45	2.38 ± 3.33	7.36 ± 6.58*	<0.0001

Values expressed as number (%), mean ± standard deviation, median (range)

DBP: Diastolic blood pressure; HR: Heart rate; SBP: Systolic blood pressure

*p value: for the statistically significant differences between selected category and other categories

en. There was a significant difference between groups. In particular, a positive correlation was observed between ED visits in the next six months and CCI score. In our study, increasing CCI scores may indicate severe cases, which may require additional care in their treatment. The development of new methods to estimate the severity of patients' clinical conditions is of great importance for improving patient health and reducing health costs.

In our study, patients with CCI scores 5 points and above were considered as high risk patients. The mean age of patients with a CCI score of 5 and above was around 70. In this group, most of the patients were elderly, and increasing age is given increasing scores in the CCI. In other words, an increase in age directly increases CCI score. A significant proportion of patients given CCI scores over 5 received them due to age, and age was the most important factor in determining the severity of patients' clinical conditions.

Patients aged 24 to 45 years had the highest frequency of reapplication to the ED, according to the National Hospital Ambulatory Medical Care Survey of America.[22] Dinh et al. stated that patients between 20 and 39 years had the highest frequency of repeat attendances within a 72 hour period. [23] Verelst et al. showed that the mean age of patients who attended for repeat examinations was 47.[24] In these studies, patients who visited ED repeatedly were usually in their thirties and forties. Unlike the literature, the majority of patients who reapplied in the six-month period in our study consisted of the 60-70 age group. We think that the main reason for this difference between our study and the common literature is the assessment of short-term readmission rates in previous studies. In our study, we examined the rate of re-admission for a long period of 6 months. And we confirmed this with an objective index. Thus, we think that we have achieved more objective and exact results compared to short term readmission rates. Walraven et al also discussed the 30-day short term results and found that the admission rate of elderly patients with chronic diseases was high, similar to our study.[25]

In our study, the distribution of CCI score by age was examined, and the mean age of patients increased in parallel with CCI score. In addition, in our study, the rate of reappearance at the ED increased as patients' age increased. There was a positive correlation between CCI and increasing age, and this was reflected in the rate of readmission. Older patients with high CCI scores had a high rate of readmission at the ED, so treatment protocols should be provided more carefully for elderly patients with CCI scores of more than 5 than for other groups.

Conclusion

This study presented a method of determining the severity of ED patients' conditions. We believe that the CCI scoring system can be used by ED clinicians to predict the risk of readmission of patients after discharge from ED. And patients with CCI values greater than 5 may be considered serious cases.

Declarations

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Author contributions

Conceptualization, K.A.O. and C.Z.; Methodology, D.S. and K.A.O; Software, D.S.; Validation, A.I., C.Z.; Formal Analysis, D.S.; Investigation, K.A.O; Resources, I.A.; Data Curation, D.S.; Writing – Original Draft Preparation, D.S.; Writing – Review & Editing, I.A.; Visualization, C.Z.; Supervision, C.Z.; Project Administration, K.A.O.

Conflicts of interest

The authors declare no conflict of interest.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval

The Ethics Committee of the Ataturk University Faculty of Medicine, Erzurum, Turkey (25.04.2018/Decision number: 4/Session number: 4)

References

1. Definition of an emergency service. *Ann Emerg Med.* 2009;54(1):143. doi: 10.1016/j.annemergmed.2016.04.040.
2. Hunt KA, Weber EJ, Showstack JA, Colby DC, Callaham ML. Characteristics of frequent users of emergency departments. *Ann Emerg Med.* 2006;48(1):1-8.
3. Pines JM, Prabhu A, McCusker CM, Hollander JE. The effect of ED crowding on education. *Am J Emerg Med.* 2010;28(2):217-220.
4. Moskop JC, Sklar DP, Geiderman JM, Schears RM, Bookman KJ. Emergency department crowding, part 1--concept, causes, and moral consequences. *Ann Emerg Med.* 2009;53(5):605-611.
5. Shiber JR, Longley MB, Brewer KL. Hyper-use of the ED. *Am J Emerg Med.* 2009;27(5):588-594.
6. Sturm JJ, Hirsh DA, Lee EK, Massey R, Weselman B, Simon HK. Practice characteristics that influence nonurgent pediatric emergency department utilization. *Acad Pediatr.* 2010;10(1):70-74.
7. Nunez S, Hexdall A, Aguirre-Jaime A. Unscheduled returns to the emergency department: an outcome of medical errors? *Qual Saf Health Care.* 2006;15(2):102-108.
8. Martin-Gill C, Reiser RC. Risk factors for 72-hour admission to the ED. *Am J Emerg Med.* 2004;22(6):448-453.

9. Sun JW, Rogers JR, Her Q, et al. Validation of the Combined Comorbidity Index of Charlson and Elixhauser to Predict 30-Day Mortality Across ICD-9 and ICD-10. *Med Care.* 2018;56(9):812.
10. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. *J Clin Epidemiol.* 1994;47(11):1245-1251.
11. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care.* 2005;43(11):1130-1139.
12. Li B, Evans D, Faris P, Dean S, Quan H. Risk adjustment performance of Charlson and Elixhauser comorbidities in ICD-9 and ICD-10 administrative databases. *BMC Health Serv Res.* 2008;8:12.
13. Sundararajan V, Quan H, Halfon P, et al. Cross-national comparative performance of three versions of the ICD-10 Charlson index. *Med Care.* 2007;45(12):1210-1215.
14. de Groot V, Beckerman H, Lankhorst GJ, Bouter LM. How to measure comorbidity: a critical review of available methods. *J Clin Epidemiol.* 2003;56(3):221-229.
15. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol.* 1992;45(6):613-619.
16. Dias-Santos D, Ferrone CR, Zheng H, et al. The Charlson age comorbidity index predicts early mortality after surgery for pancreatic cancer. *Surgery.* 2015;157(5):881-887.
17. Ather MH, Nazim SM. Impact of Charlson's comorbidity index on overall survival following tumor nephrectomy for renal cell carcinoma. *Int Urol Nephrol.* 2010;42(2):299-303.
18. Bar B, Hemphill III JC. Charlson comorbidity index adjustment in intracerebral hemorrhage. *Stroke.* 2011;42(10):2944-2296.
19. Goldstein LB, Samsa GP, Matchar DB, Horner RD. Charlson Index comorbidity adjustment for ischemic stroke outcome studies. *Stroke.* 2004;35(8):1941-1945.
20. Jimenez Caballero PE, Lopez Espuela F, Portilla Cuenca JC, et al. Charlson comorbidity index in ischemic stroke and intracerebral hemorrhage as predictor of mortality and functional outcome after 6 months. *J Stroke Cerebrovasc Dis.* 2013;22(7):e214-e218.
21. Soares I, Abecasis P, Ferro JM. Outcome of first-ever acute ischemic stroke in the elderly. *Arch Gerontol Geriatr.* 2011;53(2):e81-e87.
22. Adekoya N. Patients seen in emergency departments who had a prior visit within the previous 72 h-National Hospital Ambulatory Medical Care Survey, 2002. *Public Health.* 2005;119(10):914-918.
23. Dinh MM, Berendsen Russell S, Bein KJ, et al. Trends and characteristics of short-term and frequent representations to emergency departments: A population-based study from New South Wales, Australia. *Emerg Med Australas.* 2016;28(3):307-312.
24. Verelst S, Pierloot S, Desruelles D, Gillet JB, Bergs J. Short--term unscheduled return visits of adult patients to the emergency department. *J Emerg Med.* 2014;47(2):131-139.
25. van Walraven C, Dhalla IA, Bell C, et al. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. *CMAJ.* 2010;182(6):551-557.