ORIGINAL ARTICLE

CHARLSON COMORBIDITY INDEX IN PATIENTS DIAGNOSED WITH PERIPHERAL ARTERIAL DISEASE IN THE EMERGENCY DEPARTMENT: DETERMINATION OF SIX-MONTH MORTALITY RISK

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Abstract

Introduction: Although peripheral arterial disease is often not the primary reason for an emergency department visit, acute peripheral arterial disease is nevertheless a critical condition with a high mortality rate. We sought to evaluate the performance of the Charlson comorbidity index in predicting six-month mortality in patients diagnosed with acute peripheral arterial disease in an emergency department.

Materials and Method: This retrospective study included 197 patients (130 female, 67 male) admitted to the emergency department between January 2018 and December 2022 and diagnosed with acute peripheral arterial disease. The Charlson comorbidity index —a validated tool for assessing comorbidities— was used to evaluate the comorbidities of the patients and was compared with the six-month mortality.

Results: The median age of those who died (83 years) was significantly higher than those who did not (78 years). Age was not a statistically significant independent predictor of mortality, but cerebrovascular disease, dementia, chronic obstructive pulmonary disease, hemiplegia, diabetes mellitus, and end-organ damage due to diabetes mellitus were. A one-unit increase in the Charlson comorbidity index score was found to increase mortality risk by 30%.

Conclusion: The Charlson comorbidity index is a reliable predictor of mortality in patients with peripheral arterial disease and can be used effectively in the emergency department setting.

Keywords: Peripheral Arterial Disease; Comorbidity; Emergency Service, Hospital; Mortality; Geriatrics.

INTRODUCTION

Peripheral arterial disease (PAD) is caused by the narrowing or occlusion of arteries other than the coronary and cerebral vessels, most commonly due to atherosclerosis, (1) and primarily affects leg arteries, which causes severe morbidity (2). It is estimated that more than 230 million people worldwide suffer from PAD, so changes in the prevalence of risk factors in aging populations can have large effects on the incidence and prognosis of PAD (3).

Patients with PAD often present to the emergency department (ED) with intermittent claudication, numbness, discoloration, coldness, ulcerations, or gangrene in the affected extremity.

Patients receive diagnoses through comprehensive physical examination, Doppler ultrasonography, and peripheral angiography (4-7).

The treatment and prognosis are contingent upon several variables, including the patient's age, expectations, the stage of the disease, and comorbidities present (1,8-10).

The European Society of Cardiology (ESC) emphasizes the need for more information on the epidemiology of PAD. Likewise, reliable estimates of mortality due to PAD should be kept up to date (1). Considering recent advances in PAD management, a better understanding of trends in mortality rates will add to our knowledge of the disease and contribute to increased awareness of a condition often characterized by underdiagnosis and poor adherence to medical treatment.

The Charlson comorbidity index (CCI) is a gold standard for predicting patients' long-term prognosis and survival with comorbid diseases. As the CCI score increases, the cumulative long-term survival decreases (11,12). Although the CCI is known to be a reliable index, it is helpful to conduct recent studies in different patient groups. With the new findings obtained and the tests that include these patient groups, areas that require adaptation or rearrangement of the index can be revealed. It could enable more personalized and sensitive risk assessments in clinical decision-making details and may lead to considerable progress in patient management.

Given the complex comorbidity profiles of patients with PAD, the CCI is a valuable tool for predicting long-term survival and guiding treatment decisions. Despite advances in PAD management, there remains a critical need for up-to-date epidemiological data and mortality predictions, particularly for patients presenting to ED. Addressing this gap may improve patient outcomes through more targeted interventions, and this study therefore aimed to evaluate the performance of the CCI in predicting mortality in patients diagnosed with PAD in the ED of a tertiary university hospital.

MATERIALS AND METHOD

This study was conducted retrospectively among patients who were admitted to the ED of a tertiary care hospital between January 2018 and December 2022 and diagnosed with acute PAD. Approval was obtained from the local ethics committee (Date: February 2, 2023; Decision no: 2023/36). Patients with arterial pathology other than in the extremities (e.g., aorta, carotid artery), with duplicate admissions, who later died due to COVID-19, or who later died due to trauma were excluded.

Patient data was gathered through the hospital information management system, which is a database of anamnesis information, physical examination findings, comorbidities, routine laboratory tests (e.g., hemogram, coagulation), imaging findings (e.g., Doppler USG, peripheral angiography), and reports for each patient admitted to the hospital. Historical information about patients can also be accessed. PAD diagnoses were staged using Fontaine classification into four stages: I. asymptomatic, IIa. mild claudication, IIb.

moderate to severe claudication, III. rest pain, and IV. ulceration or gangrene (13).

The CCI is scored based on pre-existing comorbidities, which are classified according to ICD-10 codes. The components of the CCI are myocardial infarction (MI), congestive heart failure (CHF), peripheral vascular disease (PVD), cerebrovascular disease (CVD), dementia, chronic obstructive pulmonary disease (COPD), rheumatic disease, peptic ulcer disease (PUD), mild liver disease, diabetes with or without chronic complications, hemiplegia or paraplegia, renal disease, any malignancy including leukemia and lymphoma (except malignant neoplasm of the skin), moderate or severe liver disease, metastatic solid tumor, and AIDS/HIV diseases. Information on patients' deaths up to 6 months after admission to the ED was obtained from the national death registry.

Statistical Analysis

Central distributions of continuous data were evaluated with histograms, Q–Q plots, and the Shapiro–Wilk test. Central dispersion and dispersion of nonparametric continuous data were assessed by medians and interquartile ranges (IQR), while categorical data were represented by number (n) and frequency (%). The Mann–Whitney U test was used to analyze nonparametric quantitative independent data, and Student's t-test was used to analyze parametric data. Pearson's χ^2 test or Fisher's exact test were used to analyze categorical independent data. Factors thought to determine survival after initial assessment and variables found to be significant in the univariate analyses were included in a multivariate logistic regression analysis. Multiple correlation was checked using correlation analysis both before and during the regression. In all analyses, the significance level was 0.05, and the analyses were performed with the R-based *Jamovi* (Version 2.3) statistical package (The Jamovi Project, 2023).

RESULTS

The participants were 197 patients (130 female, 67 male) diagnosed with PAD in the ED of a tertiary care hospital. The median age of all participants was 79 years (IQR: 69–87), of those who died during follow-up was 83 years (IQR: 72–89), and of those who survived was 78 years (IQR: 69–86) ($p = 0.038$). PAD incidence was 13% between the ages of 45 and 54 years, 24.3% between 55 and 64, 27.1% between 65 and 74, and 31.6% over 75. Nevertheless, age was not found to be a statistically significant independent predictor of mortality (OR: 1.03, 95% CI: 1.00–1.06; $p = 0.053$).

By Fontaine classification stage, none of the 29 patients with mild claudication (stage IIa) died, 14 of the 65 patients with moderate to severe claudication (stage IIb) died (7.1%), 37 of the 76 patients with rest pain (stage III) died (18.8%), and 15 of the 25 patients with ulcers or gangrene (stage IV) died (7.6%) ($p < 0.001$). Fontaine classification was found to be an independent predictor of mortality (OR: 2.85, 95% CI: 1.90–4.27; $p < 0.001$).

The predictive value of PAD symptoms was analyzed using regression analysis; pallor (OR: 4.14, 95% CI: 2.16–7.94; $p < 0.001$), pulselessness (OR: 4.85, 95% CI: 1.94–12.12; $p < 0.001$), and claudication (OR: 4.6, 95% CI: 2.05–10.34; $p < 0.001$) were found to be independent predictors of mortality. The relationships between symptoms and mortality is shown in Table 1.

The diseases that constitute the CCI were found to have a statistically significant impact on mortality: CVD (OR: 2.56, 95% CI: 1.4–4.7; $p = 0.002$), dementia (OR: 3.07, 95% CI: 1.54–6.12; $p = 0.001$), COPD (OR: 2.03, 95% CI: 1.07–3.80; $p = 0.03$), hemiplegia (OR: 2.25, 95% CI: 1.60–3.18; $p < 0.001$), diabetes mellitus (DM) (OR: 2.22, 95% CI: 1.20–4.01; $p = 0.01$), and end-organ damage due to DM (OR: 1.55, 95% CI: 1.05–2.29; $p = 0.027$). When these diseases were included in the regression analysis, they were found to be

Table 1. Comparison of Emergency Department Admission Symptoms and Mortality

Symptoms	Survivors (n= 130) n (%)	Dead (n= 67) n (%)	Total (n= 197) n (%)	p
Pain	128 (98.5)	67 (100.0)	195 (99.0)	0.787
Pallor	54 (41.5)	50 (74.6)	104 (52.8)	**<0.001**
Paresthesia	24 (18.5)	17 (25.4)	41 (20.8)	0.344
Paralysis	15 (11.5)	11 (16.4)	26 (13.2)	0.461
Pulselessness	88 (67.7)	61 (91.0)	149 (75.6)	**0.001**
Claudication	119 (91.5)	47 (70.1)	166 (84.3)	**<0.001**

Table 2. The Effect of Diseases Composing the Charlson Comorbidity Index on Mortality

Variables	Score	Survivors (n=130) n (%)	Dead (n= 67) n (%)	Total (n= 197) n (%)	p
MI	1	40 (30.8)	24 (35.8)	64 (32.5)	0.578
CHF	1	40 (30.8)	29 (43.3)	69 (35.0)	0.113
PVD	1	63 (48.5)	34 (50.7)	97 (49.2)	0.878
CVA	1	44 (33.8)	38 (56.7)	82 (41.6)	**0.003**
Dementia	1	20 (15.4)	24 (35.8)	44 (22.3)	**0.002**
COPD	1	31 (23.8)	26 (38.8)	57 (28.9)	**0.043**
CTD	1	8 (6.2)	7 (10.4)	15 (7.6)	0.428
PUD	1	72 (55.4)	33 (49.3)	105 (53.3)	0.505
DM	1	56 (43.1)	42 (62.7)	98 (49.7)	**0.014**
Hemiplegia	2	18 (13.8)	30 (44.8)	48 (24.4)	**<0.001**
CKD	2	29 (22.3)	24 (35.8)	53 (26.9)	**0.063**
DM-End organ damage	2	15 (11.5)	16 (23.9)	31 (15.7)	**0.041**
Metastatic Solid Tumor	6	5 (3.8)	5 (7.5)	10 (5.1)	0.451
Liver Disease	1	14 (10.8)	3 (4.5)	17 (8.6)	0.104
	3	4 (3.1)	0 (0.0)	4 (2.0)	
Solid Tumor	2	19 (14.6)	15 (22.4)	34 (17.3)	0.243
Leukemia	2	1 (0.8)	0 (0.0)	1 (0.5)	1.000
Lymphoma	2	2 (1.5)	0 (0.0)	2 (1.0)	0.787

MI: Myocardial Infarction, CHF: Congestive Heart Failure, PVD: Peripheral Vascular Disease, CVA: Cerebrovascular Accident, COPD: Chronic Obstructive Pulmonary Disease, CTD: Connective Tissue Disease, PUD: Peptic Ulcer Disease, DM: Diabetes Mellitus, CKD: Chronic Kidney Disease

independent predictors of mortality. The effect of the CCI diseases on mortality is shown in Table 2.

The median CCI score was 8 (IQR: 6.0–9.0) in the surviving patient group and 10 (IQR: 8.5–12.0) in the deceased patient group ($p < 0.001$). A one-unit increase in CCI increased the mortality risk by 30% (OR: 1.3, 95% CI: 1.14–1.40; $p < 0.01$).

DISCUSSION

The CCI is a reliable and highly sensitive index known to be clinically valuable and applicable to mortality predictions (11). In our study, it was successful in predicting mortality among PAD patients, with a 1-point increase in the index predicting an increase in mortality of 30%.

PAD incidence is known to increase with age, as was also found in the current study; however, Olinic et al. found age to be an independent risk factor, which we did not find. The center where the study was conducted provides healthcare services to cities that rank among the top regarding healthy longevity statistics. Factors such as region-specific lifestyle, low stress levels, and dietary characteristics are essential reasons age is not an independent risk factor for PAD.

The data on gender in the prevalence of PAD is inconsistent. In Europe, PAD has been found to be more common among males (14). Males prevalence in PAD patients was however found to be lower in a study comparing 5 EU countries and USA (47.2 vs. 59.4%) (15).

One significant predictor of mortality is intermittent claudication. According to a 2016 meta-analysis, 91% of symptomatic PAD patients complained of intermittent claudication, and the mortality rate was higher in symptomatic patients than in reference groups (16). In our study, claudication was classified as either mild or moderate to severe, according to the Fontaine stages; when these classifications were analyzed separately, hospital admission with rest pain was more common, but when we grouped all claudication into a single group, it became the most common complaint.

Beyond symptomatic indicators like claudication, underlying conditions such as diabetes and dementia also play a crucial role. Diabetes and diabetes-related end-organ damage are strongly associated with PAD, and diabetes is more severe among PAD sufferers than the general population. Diabetes also masks the classic symptoms of PAD, such as claudication and rest pain, through neuropathic effects, which causes patients to be diagnosed later, thus increasing amputation and mortality (17). Nearly half of individuals with diabetes-related foot ulcers (DFU) are affected by peripheral artery disease (PAD), often occurring alongside neuropathy. Diagnosing PAD in diabetic patients, particularly those with DFU, is complex due to altered symptom presentation and complications like neuropathy, which may obscure typical signs such as claudication and rest pain. Initial diagnosis frequently involves non-invasive bedside tests, including the ankle-brachial index (ABI) or blood pressure measurements. However, DFU patients often present with below-the-knee or foot disease, along with medial artery calcification and lower leg edema, which can impact the accuracy of these diagnostic methods. A systematic review of 8517 abstracts and 40 studies between 1980 and 2022 concluded that diabetes should be excluded in patients with PAD, even in the absence of end-organ damage, and that it increases the incidence of PAD (18). Our study yielded similar results, with higher mortality rates for PAD patients with diabetes. According to the regression analyses, both diabetes and diabetes-related end-organ damage were independent risk factors for mortality.

In a study by Taşçı et al. on dementia and PAD, the rate of PAD was found to be significantly higher among dementia patients (35.2%) and than in the control group (16.3%), which the researchers attributed to the rapid loss of function caused by

dementia, the inability of such patients to express their concerns, and their low compliance with treatment (19). According to the data in the current study, dementia is predictive of more severe PAD and is an independent risk factor for mortality, consistent with Taşçı et al., who similarly found PAD to be more severe in dementia patients, underscoring the significance of dementia as a mortality risk factor.

According to a 1-, 3-, and 6-month follow-up study of 951 patients in Japan between 2000 and 2017, patients with CVD were more likely to have PAD and to have a higher Fontaine classification; CVD was also found to decrease life expectancy among PAD patients (20). Similar results were obtained in the current study, and it was also found that CVD was an independent risk factor for mortality, increasing the risk by 2.56 times.

In a study by Liao et al. in Taiwan between 1996 and 2010, which examined 51,869 patients with COPD and a comparably sized non-COPD group, the incidence of PAD was found to be 1.23 times higher in the COPD group. COPD patients also had lower effort capacity due to insufficient lung capacity, which can result in patients recognizing symptoms such as claudication later and thus being diagnosed with PAD at a more advanced stage, increasing mortality and morbidity (21). We found similar results, with mortality roughly double among PAD patients with COPD than those without, which was thus found to be an independent mortality risk factor. These findings suggest that special attention should be paid to COPD among PAD patients because the increased mortality risk demands more aggressive management and earlier interventions.

Common examination findings of PAD patients include pain, numbness, pulselessness, pallor, loss of motor power, and claudication, which are frequently mentioned in the literature and indicate the severity of PAD. Patients often have an opportunity for early diagnosis when consulting a physician about limping for periods of less than 10 minutes, when the rate of ischemic events is around 10–15%. However, if the patient does not receive a diagnosis, ignores the symptoms, or delays treatment, ischemia can begin, with severe vascular stenosis and symptoms such as pain, numbness, pallor, pulselessness, and loss of motor power in the limbs. This can lead to amputation and increased mortality (22). In our study, claudication increased mortality by 4.6 times, pulselessness by 4.85 times, and pallor by 4.14 times. All three were found to be independent risk factors for mortality according to the regression analyses.

CONCLUSION

The Charlson Comorbidity Index (CCI) is a reliable predictor of mortality in PAD patients presenting to the ED. Conditions such as CVD, dementia, COPD, hemiplegia, and DM significantly elevate the mortality risk. However, unlike previous studies, age is not an independent risk factor, emphasizing the need for tailored comorbidity assessments.

The CCI aids in classifying patients by comorbidity burden, guiding risk management, treatment planning, and resource allocation. It supports decision-making in discharge, postoperative care, and post-hospitalization planning. Real-time integration of CCI scoring into digital health records could enhance efficiency and enable targeted care strategies. PAD-specific protocols based on CCI thresholds may improve outcomes, especially for high-risk patients.

Future research should explore interventions targeting high-risk comorbidities and examine trends in CCI scores to understand disease progression. Comparative studies with other indices may refine mortality risk prediction in PAD patients.

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The authors agree to the conditions of publication including the availability of data and materials in our manuscript.

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