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RESEARCH ARTICLE

# The effect of clinical pharmacist-led pharmaceutical care services on medication adherence, clinical outcomes and quality of life in patients with stroke: a randomised controlled trial

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## Abstract

**Background** Stroke is a major cause of morbidity and mortality worldwide. Pharmaceutical care services play a significant role in managing the risk factors associated with stroke.

**Aim** This study aimed to examine the effects of a one-year pharmaceutical care programme on medication adherence, quality of life and clinical outcomes of patients with stroke.

**Method** This study was conducted as a randomised controlled trial at the neurology clinic of a university hospital in Türkiye. Patients were randomly assigned to either an intervention group or usual care group (IG vs UCG). A simple randomization method using computer-based random numbers was used to assign participants in a 1:1 ratio. The IG received pharmaceutical care including medication reconciliation, medication review and patient education in addition to routine health services. The medication adherence, quality of life and clinical parameters of the patients were evaluated at the beginning and the end of the 12th month.

**Results** This study included 193 patients (89 and 104 patients in the IG and the UCG, respectively; mean age: 60.1 years), of whom 67.4% were male. At the one-year follow-up evaluation, the percentage of adherent patients (86.5% vs 47.1%, $p < 0.001$) and the total Stroke-Specific Quality of Life score (184.9 vs 166.0, $p < 0.001$) were higher in the IG than in the UCG. The stroke recurrence rate at the one-year follow-up (2.2% vs 10.6%, $p = 0.044$) was lower in the IG than in the UCG.

**Conclusion** Pharmaceutical care services improved the medication adherence, quality of life and clinical outcomes of patients with stroke.

**The clinical trial registration** ClinicalTrials.gov Identifier: NCT06129318; Study Registration Date: 13 November 2023.

**Keywords** Medication adherence · Pharmacist · Risk factors · Secondary prevention · Stroke

## Impact statements

- Patient education provided by a clinical pharmacist increased medication adherence in patients with stroke.
- Quality of life was found to be better in patients with stroke who received pharmaceutical care.
- With the multidisciplinary team approach involving the clinical pharmacist patients' stroke specific risk factors were better controlled.
- Recurrences were found to be less in patients with stroke who were closely monitored by a clinical pharmacist for 1 year.

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## Introduction

Stroke is the leading cause of long-term disability and is a chronic condition that can be recurring and fatal [1]. In a population-wide cohort study, the cumulative incidence of stroke recurrence was 7.8% at 3 months, 11.0% at 1 year, 19.8% at 5 years and 26.8% at 10 years [2]. In 2019, the incidence of stroke for Türkiye was estimated as 154 per hundred thousand, the prevalence was 1.3% and stroke related death was 48 947 [3].

When considered separately from other cardiovascular diseases, stroke alone ranks fifth among all causes of death after heart disease, cancer, COVID-19 and unintentional injuries or accidents [4]. Poor adherence and discontinuation of secondary prevention medications result in poor health outcomes and significant economic burden for the governments. In this respect, targeting medication adherence may play an important role in preventing recurrent stroke and vascular events [5]. Among the treatable risk factors for stroke, hypertension, which promotes the formation of atherosclerotic lesions, is the most important [6]. Other risk factors include high blood cholesterol levels, smoking, obesity, diabetes mellitus, end-stage kidney disease, atrial fibrillation and a history of transient-ischemic attack [7]. According to the results of the Global Burden of Disease (GBD) Study, 87% of stroke risk is related to the above mentioned modifiable risk factors; 47% can be attributed to behavioural risk factors, such as smoking, a sedentary lifestyle and an unhealthy diet. Globally, 30% of stroke risk can be attributed to air pollution [8, 9].

According to a systematic review, pharmacist interventions for stroke patients in a variety of settings include participation in the stroke intervention team, assessment of thrombolytic use, medication reconciliation, attendance at medical visits, identification and resolution of medication-related problems (DRPs), control of risk factors, and patient education [10]. While in some studies the pharmacist contributed to the improvement of modifiable risk factors in patients wtih stroke, in other studies, despite this contribution, it did not reduce stroke-related hospital readmission [11–13].

Although there are numerous studies in the literature on the effect of pharmaceutical care in the management of chronic conditions such as hypertension, diabetes, and cardiovascular disease, there are fewer studies in patients with stroke that collectively evaluate the effect of 1-year pharmaceutical care on patients' medication adherence, risk factor control, recurrence rate, quality of life, and mortality.

### Aim

This study aimed to examine and report the effect of a 1-year pharmaceutical care programme on medication adherence, quality of life and clinical outcomes including recurrence rate in patients with stroke in a tertiary hospital in Türkiye.

### Ethics approval

Ethics committee approval was obtained for the study from the Marmara University Faculty of Medicine Clinical Research Ethics Committee dated 6 March 2020 and protocol code 09.2020.382.

## Method

### Setting

This randomised controlled trial (RCT) was conducted between March 2021 and May 2023 on 193 patients who were diagnosed with stroke at the Neurology Clinic and the Outpatient Stroke Clinic in the tertiary hospital of Istanbul, Türkiye. A researcher clinical pharmacist worked 8 h per day during weekdays at the same clinic.

### Inclusion–exclusion criteria and randomisation

Patients admitted to the neurology department with a diagnosis of stroke were included in this study. All the participants provided signed voluntary consent. The inclusion criteria included a diagnosis of stroke, age $\geq$ 18 years and the cognitive capability to receive the provided training. The exclusion criteria included inadequate cognitive function (e.g. due to dementia), pregnancy, lactation, and current diagnosis of cancer.

A simple randomisation method using computer-based random numbers was used to allocate the participant at a 1:1 ratio by the secretary. There was no blinding in the study. The risk of possible cross contamination was minimised by ensuring that patients assigned to the intervention group (IG) and the usual care group (UCG) did not receive services in the same inpatient rooms.

### Outcome measures

The patients were evaluated for the following parameters as primary outcomes to measure the difference between the two groups at the end of 1st, 3rd, 6th, 9th and 12th months after discharge: medication adherence, control of risk factors (changes in blood pressure, fasting plasma glucose (FPG), HbA1c, LDL cholesterol and triglyceride levels),

and body mass index. The following values of the patients were recorded as the secondary outcome measures of the study: quality of life, stroke recurrence (radiologically and clinically confirmed) within 1 year and the determination of DRPs using the Pharmaceutical Care Network Europe (PCNE Version 9.1). For each DRP, two clinical pharmacists (KNC, MS) and neurologists (IM) reached a consensus. Additionally, changes in the number of medications used for secondary prevention were also recorded. The effects of the pharmacist-led care programme on clinical outcomes and pharmacotherapy adherence were determined by comparing the baseline values with the final results for the IG and the UCG. We monitored whether the patients' stroke risk factors were on target according to the current guidelines.

## Description of the interventions

The UCG received routine medical services (medical work-up and treatment plan in both of inpatients and outpatients and follow up in outpatients) provided by their neurologist, whereas the IG received pharmaceutical care from the clinical pharmacist (K.N.C.) in addition to the provided routine medical care. After randomisation, the clinical pharmacist conducted a medication reconciliation. The sociodemographic characteristics, FPG level, haemoglobin A1c (HbA1c) value, and LDL cholesterol and triglyceride levels were obtained from the medical records. Blood pressure was checked and recorded by a qualified nurse during the hospital stay and follow-up visits. Patients in both groups were also asked to complete the Morisky Green Levine test and the Stroke Specific Quality of Life Scale (SS-QOL) questionnaire at baseline. The clinical pharmacist provided a medication review for each patient and regularly attended medical visits. Patients in the IG received verbal information about the definition and symptoms of a stroke, risk factor management and medication from the clinical pharmacist in a training session of approximately 15 min on the day of discharge, furthermore, the information given at baseline was repeated and new questions were answered in regular follow-up visits and 10–12 min phone calls every 3 months. When problems with the comorbidities of the patients were detected via telephone or in-office follow-ups, the patients were referred to the relevant physician. The interventions performed there were monitored by the clinical pharmacist.

Patients in the UCG did not receive interventions from the clinical pharmacist. Only their blood parameters were recorded, and their medication adherence was evaluated. At the end of the 1-year follow-up period, the patients in the UCG were informed about similar information to the patients in the IG. DRPs were recorded through patient records, medical visits and direct observations by the clinical pharmacist during both hospitalization and outpatient follow-up of patients in both IG and UCG, and recommendations were made to the neurologist for DRPs in IG patients.

## Adherence

Medication adherence was assessed using the Morisky-Green-Levine test [14] (translated into Turkish and validated) [15] at baseline and the 6-month and 12-month follow-ups. Patients were considered adherent to pharmacotherapy (antiplatelets, anticoagulants, statins, antihypertensives and antidiabetics) if they answered "no" to all four questions. If a patient answered "yes" to any question, the patient was considered nonadherent. On the Morisky-Green-Levine Adherence Scale (1–4), higher scores indicate higher levels of reported adherence. Permission to use the Morisky survey was received from Morisky Medication Adherence Research, LLC.

## Stroke-specific quality of life scale (SSQOL) and National Institutes of Health Stroke Scale (NIHSS)

The patients' quality of life was evaluated using the Stroke-Specific Quality of Life Scale (SSQOL) [16] (translated into Turkish and validated) [17], and the total quality of life score was calculated. SSQOL scores were measured at discharge and at outpatient clinic visits every 3 months for 1 year. The patients filled out the SSQOL questionnaire themselves. A higher score indicates that the patient has a better quality of life (min 49 and max 245). The National Institutes of Health Stroke Scale, or NIH Stroke Scale (NIHSS), is a tool used by healthcare providers to objectively quantify the impairment caused by a stroke and aid in planning post-acute care disposition. Patients' NIHSS scores were measured by neurologist 24 h before discharge and at the end of 3rd, 6th, 9th and 12th months at outpatient control. Higher values are associated with worse stroke outcomes (min 0 and max 42).

## Sample size

It is known in the literature that pharmacists increase the medication adherence rate in chronic patients by approximately 10–30% [11, 18–20]. According to the sample size calculation, 146 patients (73 per group) were estimated to provide an alpha of 0.05 and 80% power, based on the assumption that medication adherence would increase by approximately 20% in groups, including clinical pharmacist. Assuming that 20% of the patients would dropout, we planned to include at least 183 patients in the study.

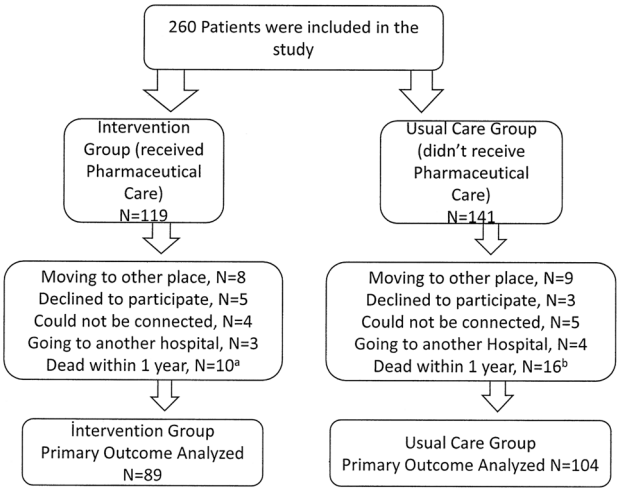


**Fig. 1** Work flow diagram. **a** Two of the ten patients died from multiple organ failure due to Covid-19 infection, one from recurrent stroke; the cause of death of the others is unknown. **b** Two of the sixteen patients died from multiple organ failure due to Covid 19 infection, two from recurrent stroke; the cause of death of the others is unknown

## Statistical analysis

Statistical analyses were conducted using SPSS (Statistical Package for Social Sciences) version 25 (Chicago, USA). The data was analyzed according to the Kolmogorov–Smirnov and Shapiro-Wilks tests. Independent-sample t tests were used for normally distributed data, and Mann–Whitney U tests were used for non-normally distributed data. Pearson chi-squared or continuity- adjusted chi-squared tests were utilised to compare the groups. Study periods (before-after) were compared with paired t tests or Wilcoxon tests. All the data were considered statistically significant, with $p < 0.05$ at the 95% confidence interval.

## Results

A total of 193 patients (67.4% male), 89 of whom were from the IG and 104 from the UCG, who were randomised and followed up for 1 year, were included in the statistical analyses (Fig. 1). The mean age and standard deviation of the patients were 60.1 years (13.81). There was no significant difference between the two groups in terms of the sociodemographic and clinical parameters, as shown in Table 1 ($p > 0.05$).

## Medication adherence and quality of life

A higher proportion of patients in IG was found to be adherent compared to UCG at 12 months (86.5% vs 47.1%, $p < 0.001$). The Morisky Adherence Score, which was a median of 3 in both groups at baseline, was found to be higher at the end of the 12th months in the IG compared to the UCG (median score 4 vs 3, $p < 0.001$). The Stroke-Specific Quality of Life total score at the end of the 12th month was found to be higher in the IG than in the UCG ($p < 0.001$). The patients' NIHSS mean scores at 12 months were significantly lower than the baseline score ($p < 0.001$); although this decrease was greater in the IG than in the UCG, the difference between the two groups was not statistically significant ($p > 0.05$). The changes in medication adherence, SSQOL and NIHSS scores of the patients before and after the study between the IG and UCG are shown in Table 2. Details of these parameters for each timepoint are given in Supplementary Table 1.

The classification of medications used by patients for secondary prevention against stroke is presented in Table 3. Accordingly, at the end of 1 year of pharmaceutical care, the number of patients using statins and antidiabetic drugs in the IG (82.0% vs 46.1%, respectively) was found to be significantly greater than that in the UCG (54.8% vs 26.9%; respectively). However, no significant difference was found in antihypertensive, anticoagulant and antiplatelet medications.

## Clinical outcomes

At the end of 12 months, the mean systolic and diastolic blood pressure value was lower in the IG than in the UCG (124.1/74.5 mmHg vs 136.9/83.8 mmHg; respectively, $p < 0.001$). When the HbA1c targets (< 7%) of 75 patients (42 intervention, 33 usual care) diagnosed with diabetes were examined, 35.7% and 30.3% of the patients were on target at baseline, respectively ($p = 0.805$); at the end of the 12th month, 76.2% of the patients in the IG and only 45.5% in the UCG reached the target values ($p = 0.013$). While the decrease in FPG (12.2 vs 0.7 mg/dL, $p = 0.045$) and triglyceride levels (44.9 vs 9.8 mg/dL p = 0.023) was statistically greater in the IG, no significant difference was observed in LDL cholesterol levels (25.6 vs 18.7 mg/dL, p = 0.204) or body mass index (BMI) (0.8 vs 0.4 $p = 0.374$). Table 4 presents a comparison of the changes in the clinical outcomes of the patients between the groups before and at the end of the study. Clinical outcomes for each timepoint are also provided in Supplementary Table 2. The stroke recurrence rate at 12 months was lower in the IG (2.2% vs 10.6%, $p = 0.044$).

## Drug-related problems

A total of 306 DRPs (151 in IG vs 155 in UCG) were identified in 193 patients in the study. The mean number of problems per patient was $1.7 \pm 1.2$ (range: 0–5) in the IG and $1.5 \pm 1.2$ (range: 0–4) in the UCG ($p = 0.207$). At least 1 DRP was detected in 85.4% of IG patients and 74.0% of UCG patients; however, this difference was not significant

**Table 1** Sociodemographic and clinical parameters between intervention and usual care groups

| Demographic and clinical characteristics | Intervention group, N = 89 | Usual care group, N = 104 | *P* value |
|---|---|---|---|
| Age in years, mean (SD) | 62.25 (13.18) | 58.17 (14.13) | 0.069 |
| *Gender, n (%)* | | | |
| Male | 55 (61.8) | 75 (72.1) | 0.128 |
| Female | 34 (38.2) | 29 (27.9) | |
| *Education, n (%)* | | | |
| Illiterate | 11 (12.4) | 7 (6.7) | 0.466 |
| Elementary | 45 (50.6) | 53 (51) | |
| Secondary school | 14 (15.7) | 14 (13.5) | |
| High school | 11 (12.4) | 21 (20.2) | |
| University | 8 (8.9) | 9 (8.6) | |
| *Risk factors* | | | |
| Hypertension, n (%) | 70 (78.7) | 77 (74) | 0.453 |
| Diabetes mellitus, n (%) | 42 (47.2) | 33 (31.7) | 0.028* |
| Hyperlipidemia, n (%) | 74 (83.1) | 75 (72.1) | 0.069 |
| History of stroke, n (%) | 25 (28.1) | 30 (28.8) | 0.908 |
| Smoking, n (%) | 40 (45) | 46 (44.2) | 0.921 |
| Alcohol use, n (%) | 7 (7.9) | 10 (9.6) | 0.669 |
| *Stroke type, n (%)* | | | |
| Ischemic stroke, n (%) | 84 (94.4) | 94 (90.4) | 0.301 |
| Hemorrhagic stroke n (%) | 5 (5.6) | 10 (9.6) | |
| *Stroke treatment* | | | |
| Tissue plasminogen activator (tPA), n (%) | 14 (15.7) | 13 (12.5) | 0.519 |
| Carotid artery stenting, n (%) | 10 (11.2) | 10 (9.6) | 0.713 |
| Thrombectomy, n (%) | 6 (6.7) | 6 (5.8) | 0.780 |
| Total Number of drugs at discharge, median (IQR) | 6 (5–8) | 6 (4.25–8) | 0.349 |
| Duration of hospital staying, median day (IQR) | 10 (6.5–12.5) | 8 (6–12) | 0.125 |

IQR, Inter quartile range; SD, Standard deviation

*Statistical significance

**Table 2** The changes in medication adherence, SSQOL, and NIHSS scores of the patients before and after the study between the intervention and usual care groups

| Outcomes | | Intervention group | Usual care group | *P* value |
|---|---|---|---|---|
| Adherent patients (MGL scale) n (%) | Baseline | 23 (32.9) | 17 (20.7) | 0.132 |
| | End | 77 (86.5) | 49 (47.5) | < 0.001* |
| SSQOL score, mean (SD) | Baseline | 135.14 (41.73) | 143.35 (43.10) | 0.249 |
| | End | 184.89 (42.65) | 166.03 (37.44) | < 0.001* |
| NIHSS, mean (SD) | Baseline | 4.74 (4.11) | 4.28 (3.94) | 0.371 |
| | End | 1.65 (2.67) | 1.57 (2.40) | 0.804 |

MGL, Morisky Green Levine; NIHSS, National Institutes of Health Stroke Scale; SD, Standard deviation; SSQOL, Stroke Specific Quality of Life

*Statistical significance

($p > 0.05$). Of the DRPs, 182 were potential problems (84 in IG vs 98 in UCG, $p > 0.05$) and 124 were manifest problems (66 in IG vs 58 in UCG, $p > 0.05$). The most common types of DRPs were: *P2.1 adverse drug event (possibly) occurring* (49.4%); *P1.2 effects of drug treatment not optimal* (34%); *P1.3 untreated symptoms or indications* present (15%) and *P3.1 unnecessary drug treatment* (1.7%). A total of 84.1% of the recommendations made by the clinical pharmacist

**Table 3** Effect of pharmaceutical care on medication use

| Medication class | | Intervention group n (%) | Usual care group n (%) | *P* value |
|---|---|---|---|---|
| Antihypertensives | Baseline | 62 (69.7) | 71 (68.3) | 0.835 |
| | End | 71 (79.8) | 82 (78.8) | 0.874 |
| Antidiabetics | Baseline | 28 (31.5) | 25 (24.0) | 0.249 |
| | End | 41 (46.1) | 28 (26.9) | 0.006* |
| Statins | Baseline | 10 (11.2) | 12 (11.5) | 0.947 |
| | End | 73 (82.0) | 57 (54.8) | < 0.001* |
| Antiplatelets | Baseline | 35 (39.3) | 49 (47.1) | 0.277 |
| | End | 64 (71.9) | 74 (71.2) | 0.908 |
| Anticoagulants | Baseline | 11 (12.4) | 6 (5.8) | 0.107 |
| | End | 31 (34.8) | 30 (28.8) | 0.373 |

*Statistical significance

to the neurologist to resolve DRPs were accepted and fully implemented. A total of 9.9% of the remaining recommendations were accepted but not implemented, while the other 6% were accepted, but their implementation status is unknown.

## Discussion

According to the present study, the pharmaceutical care provided by the clinical pharmacist had a positive effect on the clinical results of the patients, increased medication adherence, reduced stroke recurrence and improved their quality of life.

As a result of the services provided by the clinical pharmacist to the IG, the Morisky adherence score and the number of adherent patients were found to be higher at 12 months than in the UCG ($p < 0.001$). In the 6-month follow-up study conducted by Wang et al. on 166 ischemic stroke patients, which included education and counseling interventions, adherence to the medications used to control risk factors was higher, similar to our results. However, in this study, adherence to medication classes used to control risk factors was evaluated separately by Medication Adherence Report Scale-5, whereas in our study, adherence was evaluated generally for all medications [21]. Unlike our study, in a 6 months study performed by Hedegaard et al. using the medication possession ratio method, and including medication review, consultation and telephone calls interventions, there was no significant difference between the intervention and control groups for 203 stroke patients. Possible reasons for not seeing a difference in their study were that the included patients generally had minor strokes and therefore had fewer risk factors for nonadherence. In addition, there may have been information transfer between groups due to intervention and control patients being recruited from the same unit [5].

Similar to the results of our study, in the 12 months follow-up study of Hohmann et al., the health-related quality of life (HQL) outcome was better in the intervention group in which the pharmacist administered pharmaceutical care than in the control group [22]. In the clinical pharmacist-led education study conducted by Fırat et al. in Türkiye with a 3 month follow-up and using the same scale as our study, no significant difference was observed in terms of the quality of life score. Considering that there was a difference in favour of the intervention group in our study, the longer follow-up period and greater number of patients may have played a role in this result [23].

A retrospective study conducted by Nathans et al. found that the 90-day recurrent stroke rate in a pharmacist-driven

**Table 4** Comparison of the change in clinical outcomes of patients between groups

| Outcome measures | Intervention group | | | | Usual care group | | | | Between groups mean difference |
|---|---|---|---|---|---|---|---|---|---|
| | Baseline (Mean, SD) | End (Mean, SD) | *P* value | Mean differences | Baseline (Mean, SD) | End (Mean, SD) | *P* Value | Mean differences | *P* value |
| SBP, mmHg | 129.17 (12.44) | 124.10 (10.96) | 0.001* | 5.07 | 132.88 (15.53) | 136.87 (17.24) | 0.031* | −3.99 | < 0.001* |
| DBP, mmHg | 78.92 (8.67) | 74.46 (8.29) | < 0.001* | 4.46 | 82.31 (11.42) | 83.75 (11.53) | 0.214 | −1.44 | 0.001* |
| LDL-C, mg/dL | 103.76 (35.42) | 78.51 (24.65) | < 0.001* | 25.58 | 107.41 (33.74) | 88.59 (31.76) | < 0.001* | 18.72 | 0.204 |
| FPG, mg/dL | 115.05 (35.48) | 102.85 (23.81) | 0.004* | 12.20 | 110.46 (32.86) | 109.72 (35.64) | 0.760 | 0.74 | 0.045* |
| Triglyceride, mg/dL | 170.88 (135.01) | 125.95 (62.04) | < 0.001* | 44.92 | 143.58 (64.20) | 141.25 (97.77) | 0.057 | 9.76 | 0.023* |
| BMI | 28.07 (4.35) | 27.23 (4.38) | 0.002* | 0.84 | 27.83 (4.77) | 27.44 (5.18) | 0.007* | 0.39 | 0.374 |

BMI: Body mass index; DBP: Diastolic blood pressure; FPG: Fasting plasma glucose; LDL: Low-density lipoprotein; SBP: Systolic blood pressure

*Statistical significance

poststroke care transition clinic was no different from that in the control group. [24]. Moreover, in a study conducted by Wang et al. involving 166 ischemic stroke patients with a 6-month follow-up in China, no significant difference was found between the intervention and control groups in terms of stroke recurrence [21]. However, in our study, there was significantly less stroke recurrence at the end of the 1-year follow-up in the IG. This may be due to the longer follow-up period and the larger sample size of our study.

In the study conducted by Wang et al., better results were observed in HbA1c and LDL cholesterol levels in the pharmacist intervention group, and in our study, a significant difference was also observed in blood pressure values in addition to these values [21].

In a 4-month retrospective cohort study by Andres et al., blood pressure, HbA1c and LDL cholesterol levels were better in stroke prevention clinics managed by pharmacists than in patients who did not visit these clinics. However, there was no significant difference in the number of stroke-related hospital readmissions (7.0% vs 11.1%, $p=0.125$) [13].

There are studies in the literature showing that the DRP numbers detected in stroke patients vary between 0.3 and 2.5 per patient, which is close to the DRP numbers per patient we detected in our study, and it is seen that the recommendations made by the clinical pharmacist are accepted at a high rate, as in our study [25–29].

Poor adherence to preventive medication can lead to stroke recurrence and mortality in stroke survivors [30]. In this context, it is very important to ensure optimal medication adherence. Patient knowledge of stroke is independently and strongly associated with medication adherence [31]. Therefore, informing patients about stroke within the scope of pharmaceutical care services will increase patient medication adherence.

### Strengths and weaknesses

Our study is the first study in Türkiye in which pharmaceutical care is given to stroke patients by a clinical pharmacist and has a long patient follow-up period of 1 year compared to similar studies reported in literature with shorter follow-up intervals [21, 23]. However, this study also has several limitations. Cross-contamination between patients in the usual care and intervention groups may have occurred because the patients were followed by the same neurologist for 1 year. Since the patients were aware that their clinical results were being monitored throughout the study, this may have affected their medication use, regardless of the two groups. In addition, possible better outcomes in the intervention group compared to the usual care group may have been affected by the Hawthorne effect. Since the study was conducted in a single center, the results cannot be generalized. The study was not blinded and the patients were not equally distributed among the groups due to some allocation difficulties caused by the distribution of patients in inpatient rooms. When interpreting the clinical results, it should be taken into account that not all parameters were the primary endpoint of the study and the sample size was not calculated based on these results. Intention-to-treat analysis was not applied because patients who were lost to follow-up and death were not included in the analysis, and this may have affected the findings of the study. Additionally, clinical pharmacy services in neurocritical care patients were not evaluated in our study.

### Further research

Future multicentre studies involving more patients (including patients with cognitive impairments, such as dementia), can be performed in the emergency room and include a pharmacoeconomic evaluation of the pharmaceutical care service to be delivered by the clinical pharmacist should be planned. In addition, since medication adherence was evaluated only with the patients' statements in our study, the accuracy of the adherence measurement can be increased by examining community pharmacy records and measuring adherence separately by medication class in future studies.

## Conclusion

Patients in the intervention group, in which the clinical pharmacist provided patient education and follow-up, had better adherence to medication therapy, improved quality of life and better control of risk factors than those in the usual care group who received routine care services at the 1-year follow-up. Therefore, it is important to include clinical pharmacists in multidisciplinary stroke teams.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s11096-024-01811-0.

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