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# Identifying factors explaining practice variation in secondary stroke prevention in primary care: a cohort study based on all patients with ischaemic stroke in the Stockholm region

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## ABSTRACT

**Objectives** The aim of this study was to describe the practice variation in dispensation of secondary stroke preventive drugs among patients at different primary care centres (PCCs) in Stockholm region and to identify factors that may explain the variation.

**Design** Cohort study using administrative data from the Stockholm region.

**Setting** Stockholm Health Care Region, Sweden, serving a population of 2.3 million inhabitants, hospital and PCC data.

**Participants** All patients (n=9761) with ischaemic stroke treated in hospital from 1 July 2009 to 30 June 2014 were included. Of these, 7562 patients registered with 187 PCCs were analysed. Exclusion criteria were; deceased patients, age <18, haemorrhagic stroke and/or switching PCC.

**Primary and secondary outcome measures** As primary outcome the impact of PCC organisation variables and patient characteristics on the dispensation of statins, antiplatelets, antihypertensives and anticoagulants were analysed. Secondarily, the unadjusted practice variation of preventive drug dispensation of 187 PCCs is described.

**Results** There was up to fourfold practice variation in dispensation of all secondary preventive drugs. Factors associated with a lower level of dispensed statins were privately run PCCs (OR 0.91 (95% CI 0.82 to 1.00)) and the patient being woman. Increased statin use was associated with a higher number of specialists in family medicine (OR 1.03 (95% CI 1.01 to 1.05)) and a higher proportion of patients registered with a specific physician (OR 1.37 (95% CI 1.11 to 1.68)). Women had on average a lower number of dispensed antihypertensives.

**Conclusions** A high practice variation for dispensation of all secondary preventive drugs was observed. Patient and PCC level factors indicating good continuity of care and high level of general practitioner education were associated with higher use of statins. Findings are of importance to policymakers as well as individual providers of care, and more research and actions are needed to minimise inequality in healthcare.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ There are very few analyses on why the practice of cardiovascular prevention varies in primary care and no studies as regards secondary stroke prevention.
⇒ The study was based on administrative data based on all residents in a geographically defined area, thus the treatment of almost all patients with a former stroke was analysed.
⇒ The study was done with data from a registry with unbiased coverage of both hospital and primary care and based on the registration of diagnoses of ischaemic stroke, known to be of high validity.
⇒ The study was based on available information in the registry limiting the analyses and conclusions.
⇒ The outcome variables were based on dispensation data without a linked treatment diagnosis which may conceal the actual patient intake as well as detailed treatment indication.

## INTRODUCTION

Stroke is the most common cause of functional impairment in adults and the third most common cause of death after ischaemic heart disease and cancer. About 20% of the patients with stroke die within 3 months.[1–3] In 2019, there were 21 090 cases of stroke (not including subarachnoidal bleeding) in the Swedish stroke registry of which 86% were ischaemic.[1] Roughly, 10 000 Swedes suffer a transient ischaemic attack (TIA) annually.[3]

Primary healthcare in Sweden supplies most of the cardiovascular and cerebrovascular primary and secondary preventive care. This care is crucial for long-time survival and to reduce the risk for relapses. Secondary prevention in primary care includes life-style changes and medical treatment. The medications cover treatment of hypertension, antithrombotic treatment and lipid lowering statins.[3] Patients with stroke and concomitant

atrial fibrillation should usually be treated with oral anticoagulants.[3]

Medical practice variation is a complex area which can be described related to different countries, healthcare systems, regions, medical providers and practitioners.[4] Variation in medical practice is a general phenomenon and raises questions about quality, equity and efficiency of resource allocation and use. A high degree of practice variation is often linked to inferior quality and within the sphere of implementation science, authors regularly return to the problematical gap between evidence and practice in healthcare.[5] Several studies suggest that at least 30–40% of patients do not receive care according to scientific evidence, while 20% or more of the care is not needed or potentially harmful.[6]

Quality indicators are often used as tools to describe the performance of healthcare and may be related to primary care centres (PCCs), physician or patient level. They usually show greater differences when comparing physicians to each other, than when comparing hospitals or PCCs.[7] The causes for practice variation are debated and such factors as staffing, physicians' education and attitudes, patient dependent socioeconomic factors as well as disease patterns and severity, have been suggested.[7 8]

The rate of optimally combined prescriptions for secondary prevention of coronary artery disease may vary between 28.8% and 100% among different PCCs.[9] After introducing a decentralised budget for drugs, a decreased practice variation in the overall prescribing of statins between different PCCs has been shown.[10] Several articles describe practice variation in primary care covering different areas such as laboratory testing,[11] quality indicators and prescribing rates for medications.[12] There are, to our knowledge, no studies in primary care on the practice variation in secondary stroke prevention.

## OBJECTIVE

Primarily we aimed to analyse the impact of PCC organisation variables and patient characteristics on the dispensation of statins, antiplatelets, antihypertensives and anticoagulants. Secondarily, the unadjusted practice variation of preventive drug dispensation of 187 PCCs is described.

## METHODS

### Setting

Healthcare in Sweden is publicly funded and most prescribed medications are subsidised. The Stockholm region provides healthcare to approximately 2.3 million inhabitants at three levels: primary care at more than 200 PCCs, inpatient acute care at 7 hospitals and outpatient secondary specialist care at hospitals or specialist units. Residents can choose to be registered either with a specific PCC, or with a specific general practitioner (GP) at a PCC. More than 90% of the inhabitants are registered with a public or a private PCC. About 60% of the PCCs in Stockholm region are privately run but contracted on equal terms to public PCCs by the Stockholm region. It is possible for patients to change their registration when and if they want, at any point of time. The unregistered part of the population either lives in a nursing home or remains unregistered for other reasons. Physicians working at the PCCs are either specialists in family medicine, specialist registrars or junior locum doctors at different levels of education. In addition to physicians, there are also specialised district nurses and to different degrees other medical and paramedical staff at the PCC, depending on the size of the PCC.

### Study design and participants

For this registry-based cohort study, data from the Stockholm region administrative healthcare database, the VAL database, were used.[13] The VAL database contains anonymised and encrypted data on the healthcare consumption including diagnoses, dispensed drugs, PCC registering, demographic and socioeconomic data as well as characteristics and factors of organisation of every PCC in the Stockholm region.

A cohort of all patients who suffered an ischaemic stroke, registered with a PCC was created by selecting all patients living in the Stockholm region with a discharge hospital diagnosis of ischaemic stroke in the Stockholm region between 1 July 2009 and 30 June 2014 (index period) from the VAL database.[13] The ICD-codes (International Classification of Diseases) used for data extraction are described in detail in online supplemental table S1.

Of the 200 PCCs, 13 PCCs were excluded from the study, as they are part of a separate healthcare system not comparable to the others. Patients registered with a PCC or a GP between 1 July 2014 and 31 December 2015 (study period) were selected, excluding patients deceased before the end of the index period. Patients who had also suffered haemorrhagic stroke, changed PCC or were younger than 18 years old were also excluded (figure 1).

The outcome variables were the number of dispensations of recommended preventive medications to patients who had a stroke during the study period. Medications were divided into four groups: antiplatelet drugs (ATC codes (Anatomical Therapeutic Chemical Classification) B01AC06, B01AC07 and B01AC04), antihypertensive drugs (ATC codes C03, C07, C08 and C09), statins

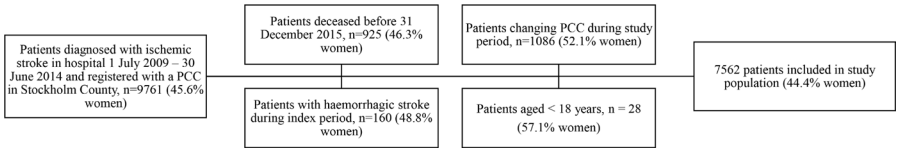


**Figure 1** Flow chart of the study population. Patient data collected from the VAL database. PCC, primary care centre.

(ATC code C01AA) and for patients with concomitant atrial fibrillation, anticoagulants (ATC codes B01AA03, B01AE07, B01AF01, B01AF02 and B01AF03). Two or more dispensed prescriptions during the study period (18 months), were considered sufficient to be interpreted as if the patient was on continuous treatment. The number of dispensations was collected from the VAL database, which has more than 99% coverage in relation to all dispensations.[13] It should be noted that Swedish reimbursement regulation implies that patients are only entitled to financial support for their medication for 3 months per refill. A new refill may only be dispensed after two-thirds of the refill interval have elapsed. Most patients on regular treatment have large medication discounts with a successive increase during a 12-month period, due to high costs. Consequently, many patients collect prescriptions for 3 months, every other month to save money and may have an excess of 4 months use before the end of the 12-month period. Also, all aspirin preparations of 75 mg tablets within the reimbursement system may not be purchased without a prescription. Aspirin over the counter is only sold in small quantities and in analgesic doses greatly exceeding 75 mg and to considerable higher prices.

PCC characteristics (online supplemental table S1) as well as patient characteristics were collected from the VAL database and investigated in relation to the dispensation of medications to identify factors influencing quality indicators. The PCC factors included physician staffing, the proportion of specialists in family medicine and the proportion of patients registered with such a specialist. Patient-related factors that were also included in the analyses were sex, socioeconomic status, comorbidity and the proportion of patients' physician visits in other parts of the healthcare system.

The Mosaic index was used as a socioeconomic marker at grouped PCC level.[14] The index, where 1 corresponds to the highest neighbourhood socioeconomic status and 3 the lowest, are linked to small geographical areas within the county and every patient is given a Mosaic number based on their registered address.[14]

The Strengthening the Reporting of Observational Studies in Epidemiology criteria were adhered to when reporting our findings.

## Patient and public involvement

As this was an exploratory study based on administrative data, we deemed it not possible to involve patients or the

**Table 1** Baseline characteristics of all patients with ischaemic stroke during 5 years in the Stockholm region

| | Women | Men | Total |
|---|---|---|---|
| Total number of patients (%) | 3360 (44.4) | 4202 (55.6) | 7562 (100.0) |
| Age groups (% within group) | | | |
| 18–64 | 641 (19.1) | 1123 (26.7) | 1764 (23.3) |
| 65–74 | 802 (23.9) | 1252 (29.8) | 2054 (27.2) |
| ≥75 | 1917 (57.0) | 1827 (43.5) | 3744 (49.5) |
| Median age in years (range) | 75.0 (18–103) | 71.0 (21–100) | 73.0 (18–103) |
| Cardiovascular comorbidity (%) | | | |
| Patients with atrial fibrillation | 841 (25.0) | 985 (23.4) | 1826 (24.1) |
| TIA (during index period) | 227 (6.8) | 307 (7.3) | 534 (7.1) |
| Ischaemic heart disease | 590 (17.6) | 989 (23.5) | 1579 (20.9) |
| Peripheral vascular disease | 406 (12.1) | 464 (11.1) | 871 (11.5) |
| Heart failure | 457 (13.6) | 591 (14.1) | 1048 (13.9) |
| Hypertension | 2328 (69.3) | 2832 (67.4) | 5160 (68.2) |
| Diabetes mellitus type 1 or 2 | 483 (14.4) | 865 (20.6) | 1348 (17.8) |
| Socioeconomic index groups* (%) | | | |
| Mosaic group 1 | 1312 (39.0) | 1789 (42.6) | 3101 (41.0) |
| Mosaic group 2 | 624 (18.6) | 719 (17.1) | 1343 (17.8) |
| Mosaic group 3 | 1412 (42.0) | 1655 (39.4) | 3067 (40.6) |
| Data missing | 12 (0.4) | 39 (0.9) | 51 (0.7) |
| PCCs' mode of operation (%) | | | |
| Public | 1413 (42.1) | 1881 (44.8) | 3294 (43.6) |
| Private | 1947 (57.9) | 2321 (55.2) | 4268 (56.4) |

*Mosaic group 1 corresponds with the highest socioeconomic status and 3 the lowest.
PCC, primary care centres ; TIA, transient ischaemic attack.

public in the design or reporting of our research at this stage.

### Statistics

A large set of variables (online supplemental table S1) were collected from the VAL database, some of which were patient related and some PCC related. All PCC variables were then linked to individual patients registered with that PCC, enabling logistic regression analyses on an individual level. By doing so we calculated the ORs for dispensing medications by the different exposure variables. We adjusted for several potential confounders: age, sex, socioeconomic status and the size of the PCC, as well as diagnoses of ischaemic heart disease, peripheral vascular disease and diabetes mellitus. Apart from logistic regression analyses, we used basic statistics to describe our cohort using mean, median, range, stratification and proportions. Since most of our data were not normally distributed, median values rather than means are presented for several of the variables. The software used for analysis was Stata Statistics/Data Analysis V.14.2 and IBM SPSS Statistics V.24. P values<0.05 were considered statistically significant. Two-sided tests were used in all significance testing.

## RESULTS

During 1 July 2009 to 30 June 2014, 7562 patients had a diagnosis of ischaemic stroke in Stockholm region. The median age for both sexes was 73 years, ranging from 18 to 103, 44.6% being women (table 1).

Basic characteristics of the PCCs are presented in table 2.

On average, for all PCCs, 67.0% of all patients were dispensed at least two prescriptions of statins during the study period, 67.4% were dispensed antiplatelets, 79.4% antihypertensives and in the subgroup of patients who are post stroke with atrial fibrillation 80.5% were dispensed anticoagulants. Proportions of dispensation in relation to registered patients who had a stroke varied up to fourfold among different PCCs, 33.3–100% for statins, 33.3–100% for antiplatelets, 61.1–100% for antihypertensives and 25.0–100.0% for anticoagulants (figure 2A–D).

Logistic regression analyses of the association between different organisational factors on PCC level and dispensation of secondary stroke preventive medications were statistically significant for dispensation of statins, but not for antiplatelets, antihypertensives and anticoagulants. A lower proportion of patients were dispensed statins at private PCCs, at PCCs with a majority of patients with visits at another caregiver and at PCCs with a majority of patients not registered with a specific GP. Female sex was also associated with a lower dispensation of statins. Yet, there were more dispensed statins at PCCs with the largest proportion of patients registered with a named specialist and for every additional specialist at a PCC (table 3).

Privately run PCCs had an OR of 0.90 of their patients being dispensed statins, compared with publicly run PCCs (table 3). Furthermore, the quartile of PCCs with the highest proportion of registered patients with visits at other caregivers than their GP, had lower odds (0.79) of their patients being dispensed statins. The quartile of PCCs with the highest proportion of patients registered with a specific specialist show increased odds (1.37) of their patients being dispensed statins. On the contrary, the quartile of PCCs with the highest proportion of patients not being registered with a specialist in family medicine showed lower ORs (0.81) for the likelihood of their patients to be dispensed statins. For each additional

**Table 2** Characteristics of primary care centres (PCCs) in the Stockholm region

| | Public | Private | Total |
|---|---|---|---|
| Total number of PCCs (%) | 69 (36.9) | 118 (63.1) | 187 (100.0) |
| PCCs grouped on number of registered patients (%) | | | |
| ≤9999 patients | 34 (49.3) | 74 (62.7) | 108 (57.8) |
| 10 000–19 999 patients | 30 (43.5) | 38 (32.2) | 68 (36.4) |
| 20 000–30 091 patients | 5 (7.2) | 6 (5.1) | 11 (5.9) |
| Median number of registered patients (range) | 10 008 (1683–30 091) | 8028 (1475–29 162) | 9175 (1475–30 091) |
| Median number of patients with stroke (range) | 38 (6–133) | 35 (3–116) | 37 (3–133) |
| Median number of physician visits/year (range) | 15 986 (3306–55 447) | 16 238 (51–79 691) | 16 216 (51–79 691) |
| Median number of physician visits/year/patient listed (range) | 1.91 (1.07–6.05) | 2.03 (1.07–6.05) | 1.77 (1.39–3.06) |
| Fragmentation of care (mean % of listed patients with visits at other caregivers than their PCC) (range) | 69.8 (61.1–76.2) | 74.9 (55.8–99.9) | 73.0 (55.8–99.9) |
| Median number of specialists in family medicine (GPs) available to registering (range) | 6 (1–23) | 4 (0–22) | 5 (0–23) |

GP, general practitioner.

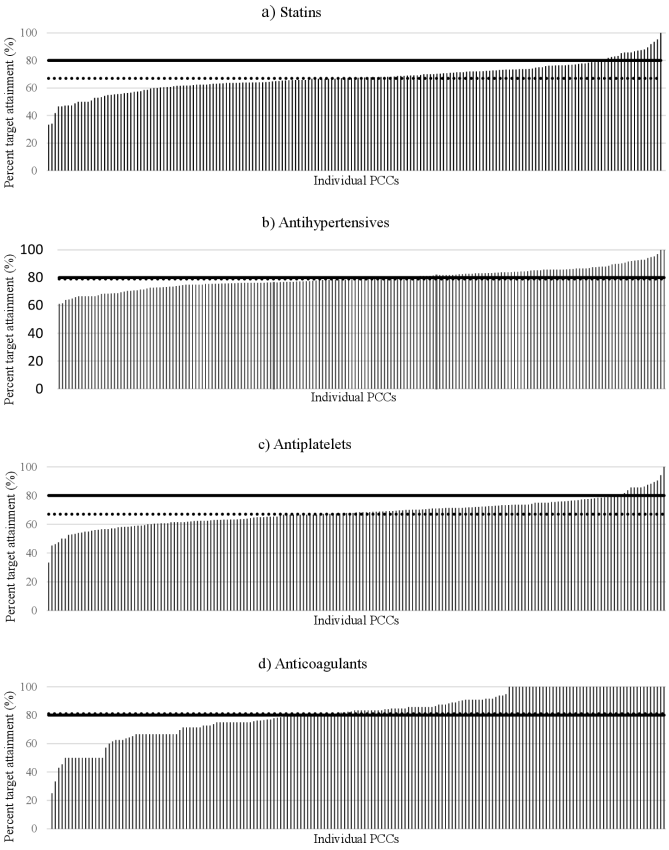


**Figure 2** (A–D) Dispensation of medications to all PCCs' patients. Proportions of all 187 PCCs' patients who had a stroke who during the study period were dispensed each of the recommended medications at least twice. Proportions have been sorted ascendingly for every group of medications, therefore PCCs are not necessarily in the same position for the different medications. Solid lines (____) denote recommended target levels (80%) by the Swedish National Board of Health and Welfare.[2 3] Dotted lines (……) denote mean levels of PCCs. PCC, primary care centres.

specialist in family medicine working at the PCC, adjusted for the size of the PCC, the odds were increased with 1.03 for patients with stroke to be dispensed statins.

There were no significant differences in the association between these quality indicators and with dispensed antihypertensive, antiplatelet or anticoagulant drugs.

## DISCUSSION

### Key results

In this cohort study based on registry data, we found an upto fourfold variation of practice among PCCs in the dispensation of secondary preventive drugs to patients post stroke in primary care. Statins were dispensed to on average of 67% of the patients as opposed to the national target of 80% or more.[3] We found that patients who had registered with a privately run PCC, patients unregistered with a specific specialist and female sex, were all factors associated with less dispensed statins. Conversely, patients registered with a named specialist and patients registered with a PCC having a higher proportion of specialists in family medicine, were factors associated with patients being dispensed statins. No systematic associations were seen explaining practice variation for other recommended drugs.

### Potential explanations

*Statins* as lipid lowering drugs for prevention of cerebrovascular disease have been included in national and international guidelines since 2009 and are the most recent group of medications introduced for secondary stroke prevention.[15 16] The treatment regimen with statins has been debated regarding effectiveness in primary prevention, but particularly about their side effects.[17] Several studies have shown a lower use of statins, than other secondary preventive drugs, in keeping with our findings.[18–20] As for most preventive drugs in cardiovascular disease, the evidence underpinning recommendations for secondary prevention of stroke is weaker in patients aged 75 years or more. Several analyses though, have indicated that the preventive effects seem to be as good in the elderly as in younger patients.[21] Most international and national guidelines thus, do not discern patients based on age.

One reason statins were not dispensed to the same extent to patients at privately run PCCs may be linked to the way they were introduced in the Stockholm region. In 1994, the privatisation process began in this region and at the start, some already well-functioning clinics went from being publicly run, to be owned by the employees. During the study period (2014–2015), the healthcare system changed, enabling new, smaller and private clinics to be established. A higher number of patient visits was financially crucial, to obtain a good balance sheet. One hypothesis is that this may have resulted in PCCs prioritising patients seeking care for more acute conditions and not favouring the care for chronic diseases in patients, with high care needs.[22]

In the quartile of PCCs with the largest proportion of patients registered with a certain specialist, the odds for patients being dispensed statins were highest. One may assume that being registered with a specific GP specialist leads to better continuity of patient care, a factor known to be associated with higher quality of care, reduced morbidity and mortality for chronic conditions.[23 24] For patients registered with the PCC and not with a certain GP specialist, it is possible that patients to a larger extent have their consultations with different physicians from time-to-time, leading to poorer continuity. In an Australian study, better continuity of care was associated with better drug adherence for statins, supporting the findings in our study.[25]

Another finding linked to the lack of continuity of care, is that being registered with a PCC with a high degree of fragmentation of care to different caregivers, was associated with lower dispensation of statins. Fragmentation of care and lack of communication between different segments of the healthcare system is a common problem in many countries[26] leading to polypharmacy,[27]

Table 3 Logistic regression models for the association between PCC characteristics and secondary prevention of stroke with statins. OR, (95% CI) and statistical p value.

| Factors of exposure | Statins | Antiplatelets | Antihypertensives | Anticoagulants* |
|---|---|---|---|---|
| Privately run PCC† | **0.90 (0.82 to 0.10) p=0.045** | 0.98 (0.85 to 1.12) p=0.740 | 1.03 (0.92 to 1.16) p=0.602 | 0.99 (0.78 to 1.26) p=0.944 |
| For every additional GP (specialist) at the PCC† | **OR 1.03 (1.01 to 1.05) p=0.011** | OR 0.99 (0.96 to 1.02) p=0.572 | OR 0.10 (0.97 to 1.03) p=0.864 | OR 1.01 (0.95 to 1.06) p=0.839 |
| The 25% of PCCs with the largest fragmentation of care among patients† | **0.79 (0.69 to 0.90) p=0.001** | 0.92 (0.75 to 1.12) p=0.395 | 0.86 (0.73 to 1.02) p=0.081 | 0.89 (0.65 to 1.22) p=0.453 |
| The 25% of PCCs with the largest proportion of patients registered with a named GP† | **1.37 (1.11 to 1.68) p=0.003** | 1.19 (0.89 to 1.60) p=0.245 | 1.06 (0.83 to 1.36) p=0.627 | 1.11 (0.69 to 1.79) p=0.656 |
| The 25% of PCCs with the largest proportion of patients registered only with the clinic† | **0.81 (0.70 to 0.94) p=0.005** | 0.92 (0.75 to 1.13) p=0.416 | 1.00 (0.84 to 1.19) p=0.982 | 1.07 (0.75 to 1.51) p=0.715 |

Significant OR marked as bold values.
*Only for patients with concomitant diagnosis of atrial fibrillation.
†Adjusted for the total number of registered patients (size of PCC), patients' age, sex, socioeconomic level and comorbidity.
GP, general practitioner; PCC, primary care centre.

multimorbidity[24] and a lack of overview of the patients total medical situation. It may also result in difficulties in implementation of new methods and guidelines.[28]

*Women* were dispensed fewer statins than men in our study. This corresponds with previously shown data that women to a lesser degree are prescribed drugs preventing cerebrovascular disease, even after adjusting for age and comorbidity; the reasons are not clear.[29–31]

It has been shown in other studies that *lower education level and lower income* are factors associated with lower dispensation of statins, a finding which was not reproduced in our study.[31]

For *secondary preventive medications other than statins*, we found no systematic association with any of our investigated PCC-dependent variables and target achievement. Antihypertensives have been on the market for the longest time, thereafter antiplatelets and the last medications introduced were the statins. Thus, the time a preventive practice has been in use may influence target achievement. During the time of our study, several changes in this therapeutic area were implemented, such as the introduction of the non-vitamin K oral anticoagulants and the $CHA_2DS_2$-VASc index. The use of anticoagulant therapy in our study was low compared with more recent findings in the primary care population in Stockholm, reflecting a successful implementation of new guidelines.[32] Patients with atrial fibrillation treated with oral anticoagulants constitute a small group in this study and there could potentially be PCCs that are outliers, with very few patients by random distribution contributing to a large crude practice variation seemingly greater than adjusted for practice size. Most patients treated with oral anticoagulants as secondary prevention have their medications initiated in hospital care and therefore, factors in primary care may be of little importance.[32]

The target attainment was relatively high and the degree of practice variation low observing *antihypertensive treatment* which is recommended for secondary use after stroke regardless of blood pressure level. One may speculate as to whether this was due to the treatment of hypertension, which is usually introduced as a primary preventive measure and may have been used by the studied patients before having their stroke. An important finding though was the fact that women were dispensed fewer antihypertensives. This has earlier been described in a primary care population of patients who had hypertension including those with cerebrovascular disease.[33] The lack of other significantly associated factors with PCC organisation for antihypertensives may be linked to the observed high target achievement. To be able to show more systematic associations, a bigger cohort of patients, would have been needed.

Although there are clear clinical guidelines for the prescription of secondary preventive medications after stroke, the details of the *translation of these recommendations to clinical practice* is poorly understood.[4] Non-adherence for patients with stroke to prescribed secondary preventive drugs may be a problem in general.[34 35] Lindblom *et al* found that the majority of patients did not clearly understand possible side effects of their medications, which is a well-known cause for non-adherence.[36] Furthermore, patients with stroke constitute a vulnerable group who may need extra support due to cognitive problems.[36] Thus, special attention to these areas influencing drug adherence may be warranted.

In our study, one of the findings was that *PCCs with more well-educated doctors* were associated with higher dispensation of secondary preventive medications. Education and professional continuing development systems seem to be important factors in reducing the gap between evidence

and practice.[37 38] Educational outreach visits alone or combined with other interventions, have been shown to have effects on prescribing in randomised trials.[39] This strategy seems to correspond to the needs of GPs, who express the importance of more consistent information about new and also existing drugs.[40] GPs seem to vary in their perception of their responsibility, for the patients' drug list.[41] When medications have been initiated by another physician as for most patients post stroke, the issue of responsibility of managing preventive strategies may be of importance and partly explain the findings in our study. More research on the process of patient transition from hospital to primary care may thus be needed.[41]

*External factors* such as reimbursement or local financing structures may also impact on drug prescribing.[10] In a Swedish study, the use of recommended statins increased from 77% in 2003 to 84% in 2005, with more cost-effective prescribing as well as a lower practice variation after changing the economic responsibility for drug costs from the regional healthcare authorities to the local PCCs.[10] As PCCs did not have the economic responsibility related to their drug prescribing in Stockholm county, this may thus have influenced both practice variation and target attainment in our study.

### Strengths and limitation

A main *strength* in our study lies in it being an epidemiological registry-based study with a large cohort of patients giving statistical power to our results. As the registry covers both hospital and primary care, we were able to follow patients over caregiver boundaries. This gave us an opportunity for an unbiased exploration of all the PCCs involved, with the same comprehensive method of data collection, without large systematic errors in data capture.

Although the method of data capture from an administrative database entails strength it also *limits* the analysis and conclusions based on the available information. The fact that our outcome variables are based on the dispensation and not the intake of medications may conceal the actual drug use by patients. Another limit is that we did not include any information on the underlying diagnosis for dispensed medications nor any information of adverse effects. The secondary preventive medications may thus be used for different conditions. We do not think that this may have been a major limitation, as our analyses were adjusted without a change in results by the main comorbidities where our investigated prophylactic drugs are used. The study was conducted in the population of Stockholm county, thus having the disadvantage of being a predominantly urban population. However, focusing on a well characterised region brought us the benefit of investigating a uniform healthcare system.

We chose to analyse the effect of different factors on practice variation in relation to two refills giving a possible theoretical coverage of between 17% and 72% of the 18-month interval studied, taking Swedish reimbursement regulation into account. The clinical relevance of this method may be questioned in the light of the interesting paper by Dalli *et al*,[42] where a positive relation of an adherence measured as proportion of days covered exceeding 60% was seen in relation to all-cause mortality.

Aspirin is recommended in 75 mg doses for prophylactic use after stroke. Aspirin may be acquired without prescription over-the-counter (OTC) in Sweden, but only in analgesic dose levels and to a considerably higher cost than the reimbursed 75 mg preparations. Thus, we do not think that OTC-drugs containing aspirin impacted on results to an important degree.

The study was performed on data reflecting the situation of 2015, thus questioning the timely relevance of the findings. In a recent preliminary analysis from the national Swedish quality register for stroke care (Riksstroke), the observed sex differences remain.[43] In regularly collected quality data in the Stockholm region, dispensation of statins was on average 61% in primary care for 2016 to patients with a diagnosis of stroke and/or TIA, compared with, on average, 68% in 2020 and with a great practice variation between PCCs. We therefore think that our description and analyses may still be relevant.

Our study results are also limited in relation to several other factors possibly influencing quality in primary care. According to a systematic review of implementation research in primary care, a conceptual framework has been suggested describing key elements influencing implementation of change in primary care. This framework covers four levels: external context, organisation, professional and intervention.[44] In relation to this framework many perspectives were not explored in our study. Thus, the available resources and professional cultures at different PCCs as well as the attitudes to change may differ.[44] Different kinds of leadership, work processes and organisational systems at different PCCs may also be important as well as how new guidelines are implemented.[44] Further studies in these areas are needed.

## CONCLUSIONS

This register-based cohort study shows a significant practice variation for all recommended secondary stroke preventive drugs, where the greatest variation was observed for statins. Possible explanatory associations could be determined for statins, but not for the other drugs.

These findings are of importance to policymakers as well as individual providers of care, and more research and actions are needed to minimise inequality in healthcare.

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**Contributors** MW and JKH: contributed to the study design, researched the literature, researched data, contributed to analysis and interpretation of data and drafted the manuscript. AC: contributed to the study design, contributed to analysis and interpretation of data and drafted the manuscript. JH and MvE: came up with

the original idea, contributed to the study design, contributed to analysis and interpretation of data and critically revised the manuscript. JH is the garantor of the manuscript. All authors approved the final manuscript.

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**Patient consent for publication** Not applicable.

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**Data availability statement** Data are available upon reasonable request. Aggregate pseudonymised data may be requested from halsodata.rst@regionstockholm.se if deemed to comply with the GDPR.



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