# The population effect of a national policy to incentivize chronic disease management in primary care in stroke: a population-based cohort study using an emulated target trial approach

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## Summary

**Background** Governments are investing in primary care policies that support chronic disease management. Large scale population-based evaluations are lacking. We aim to determine the effectiveness of government-funded chronic disease management policies to improve long-term outcomes (survival, hospital presentations, and preventive medication adherence) following stroke/Transient Ischemic Attack (TIA).

**Methods** Using a population-based cohort we utilized the target trial methodology. Participants were identified through the Australian Stroke Clinical Registry (January 2012–December 2016) from 42 hospitals in the states of Victoria and Queensland and linked with state and national hospital, primary care, pharmaceutical, aged care, and death datasets. Registrants living in the community, not receiving palliative care and who survived to 18 months following stroke/TIA were included. The comparison was a Medicare claim for policy-supported chronic disease management, 7–18 months following stroke/TIA versus usual care. Outcomes were modelled using multi-level, mixed-effects inverse probability of treatment weighted regression.

**Findings** 12,368 registrants were eligible (42% female, median age 70 years, 26% TIA), 45% had a chronic disease management claim. The difference in mean outcomes for participants with a claim, compared to those without, showed a 26% lesser mortality rate (adjusted hazard ratio [aHR]: 0.74, 95% confidence interval [CI]: 0.62, 0.87) and a greater adjusted Odds Ratio [aOR] of being adherent with preventive medications: antithrombotics (aOR: 1.16, 95% CI: 1.07, 1.26); lipid-lowering (aOR: 1.23, 95% CI: 1.13, 1.33). Impacts on hospital presentations were variable.

**Interpretation** Government policies that financially support primary care physicians to provide structured chronic disease management improve survival in the long-term following stroke/TIA.

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**Keywords:** Chronic disease management; Primary care; Stroke; Data linkage; Target trial

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## Research in context

### Evidence before this study

Evidence from large randomised controlled trials support the use of pharmacological and lifestyle/behaviour interventions, for secondary prevention of cardiovascular events following stroke or Transient Ischaemic Attack (TIA). However, there is limited evidence to support sustained uptake and use of these interventions at the primary care level in the long-term. Primary care chronic disease management policies, that promote multidisciplinary care and self-management support within a continuous care model, have been implemented by governments to assist primary care practitioners to better support patients living with chronic conditions. However, evidence for these policies is uncertain, and hindered by a lack of high-quality data.

We performed an Ovid-Medline search for articles published from January 1, 2000 to October 18, 2022. The following search strategy was used: [(Stroke OR poststroke or cerebral vasc$ OR cerebrovasc$ OR Cerebrovasc$ accident OR Ischem$ stroke OR Intracerebra$ haemorrhage OR Intracerebral$ haemorrhage OR Brain ischemia OR Transient Ichaemic Attack OR Transient Ischemic Attack OR TIA). tw.] AND [Chronic disease management. mp. OR (exp Disease Management/) OR (GP or general practice or primary care). mp.] AND [(Mortality OR death OR survival OR hospital readmission OR hospital utilization or hospital Utilization OR hospital presentation$ OR secondary prevention). mp.]. The search was limited to adults, and to study designs such as observational studies and trials with no limit by language. A small number of trials were identified from countries such as Australia, China, India, Japan and Spain. Results were variable with the better quality studies showing no difference between intervention and control groups for primary outcomes which were limited to cardiovascular risk factors. Results were frequently hindered by contamination and loss to follow up and were not powered for outcomes such as survival. We found no examples of real-word population evaluations of chronic disease management programs or policies.

### Added value of this study

To our knowledge we provide the only national evaluation of a primary care policy aimed at incentivising primary care practitioners to provide structured and comprehensive chronic disease management. Our use of routinely collected state and national data, linked with a clinical registry, provided robust case ascertainment, a large sample size, identification of policies of interest and reliable ascertainment of outcomes. To ensure the robustness of our results we used the emulated target trial approach, a structured process for designing real-world studies in order to emulate randomised controlled trials (RCTs). This approach ensured that flaws associated with observational studies, other than those due to a lack of randomisation, were minimised. The use of Inverse Probability Treatment Weights (IPTW) to reduce bias for 42 baseline variables and the application of systematic bias analyses ensured the robustness of our results. The use of real-world data allowed sufficient sample size (N = 12,368), and population coverage to obtain accurate estimates of the average population effect of chronic disease management policies for policy relevant outcomes such as survival, hospital presentations and medication adherence.

### Implications of all the available evidence

Our results, when considered against the limited available evidence, demonstrate that at a population level, investments in policies that support the primary care practitioners to provide structured chronic disease management, improves survival following stroke or TIA. When delivered as a national policy within a universal healthcare system, benefits were consistent across subgroups including socioeconomic strata, metropolitan vs rural and sex. Our results support the benefits of government investment in these policies. Despite the benefits demonstrated in our study, use of these policies was suboptimal (45% of our cohort), highlighting the need to promote uptake at the primary care level if maximum benefit is to be achieved. There is potential of policies such as these to be implemented in other countries with universal healthcare or primary care subsidised systems.

## Introduction

Stroke is a lifelong condition making it the third greatest cause of global Disability Adjusted Life Years and second for those aged ≥50 years.[1] Survivors of stroke have an elevated risk of recurrent stroke (approximately 11% at 1 year, 26% at 5 years),[2] and most have additional comorbid conditions.[3] There is compelling evidence for the use of pharmacological interventions[4,5] and emerging evidence for the use of lifestyle/behaviour interventions, for secondary prevention of cardiovascular events following stroke,[6,7] but uptake of such interventions is sub-optimal.[8] Long-term physical and psychological impairments are also common following stroke with new evidence that addressing impairment related needs may improve long-term health and social outcomes.[9] Because regular reviews beyond six months after stroke, are not part of routine practice in most countries, primary care physicians (also known as general practitioners) predominantly manage these patients, with variable success.[10]

In response to global ageing, a number of developed countries have invested in policies to support models of primary care that include chronic disease management, cardiovascular risk factor screening, and care coordination.[11–13] The overarching aim of these policies is to promote multidisciplinary care and self-management support within a continuous care model that is integrated across the healthcare sector.[14] Financial incentives

are typically provided to primary care physicians to facilitate uptake. Although these policies are designed to support a broad range of chronic conditions, they may specifically benefit people living with stroke to receive more comprehensive person-centered primary care, including ongoing review, goal setting and management of risk factors, comorbidities, and impairments.[15] Despite the potential benefits, evidence for these policies is uncertain, and hindered by a lack of high-quality data. Within the context of stroke, there is no clear evidence of efficacy for primary outcomes, which are limited to risk factor reduction.[16–18] Trials have not been adequately powered to detect changes in policy relevant outcomes such as survival or hospital presentations.

The objective of this study was to determine the average population effectiveness of Australian Medicare-funded chronic disease management policies in primary care for improving the long-term outcomes of people with stroke/TIA, including survival, hospital presentations and medication adherence.

## Methods

### Study design

PRECISE is a population-based cohort study established using population linked data and defined using target trial emulation—an established framework based on inclusion and exclusion criteria similar to that of a trial and adjusting non-randomized treatment allocation using inverse probability treatment weights (IPTW).

### Data sources and setting

The cohort was derived from the Australian Stroke Clinical Registry (AuSCR).[19] Analysis was restricted to adult registrants who attended one of 42 public hospitals in two of the seven Australian states and territories, Victoria and Queensland, between January 2012 and December 2016, and resided within these states. Victoria and Queensland account for 46% of Australia's population providing a geographically diverse cohort. Victoria is the second smallest and most densely populated state, and is home to 30% of Australia's new migrants. Queensland is the second largest state but has a smaller population and fewer migrants.[20] Based on the Australian Statistical Geography Standard Remoteness Structure, Victoria consists almost entirely of urban and regional areas whereas Queensland also contains some of Australia's most remote regions. Hospital participation in the registry is funded with government support in these states, maximising participation and case-ascertainment. The AuSCR includes prospectively collected demographic and clinical data on all clinician-identified cases of stroke (excluding subarachnoid haemorrhage) or TIA, using an opt-out method of consent (<3% opt-out rate).[19]

Data from the following routinely collected databases were linked to the AuSCR cohort: (i) the *Medicare Benefits Schedule (Medicare)* claims database containing transactional data for all medical services subsidised under Australia's universal healthcare scheme; (ii) the *Pharmaceutical Benefits Scheme (Pharmaceutical dispensing)* database containing a record of medications dispensed for all items subsidised by the Australian Commonwealth government. Medications supplied without a prescription (e.g. aspirin), privately purchased, or funded under other specialty schemes are not included (~10%); (iii) the *National Death Index (NDI)* containing information on date of death; (iv) the *National Aged Care Data Clearinghouse (NACDC)* containing information on admission to residential aged care homes; (v) *Admitted and emergency department (ED) patient data (Victoria and Queensland)* containing information on all inpatient discharges from all public, private, psychiatric and repatriation hospitals, and presentations to most public and private EDs. See Supplemental eTable S1 for additional details.

### Treatment description

Since 1999, the Australian government has invested in chronic disease management policies within primary care, through Medicare-funded financial incentives (Supplemental eTable S2).[21] Primary care physicians can claim an additional amount (almost 50%) on top of a prolonged standard consultation fee. These policies support the development of chronic disease management plans which are expected to be developed in partnership with the patient and describe in writing: healthcare needs and relevant conditions/comorbidities, management goals and mutually agreed action plans, treatments and services required, and a review date for the plan (recommended every 3–6 months).

### The protocol for the emulated target trial

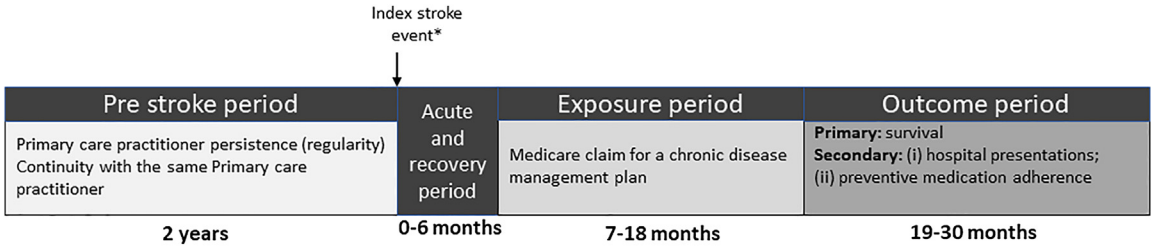
The target trial emulation provides a structured process for designing real-world studies, ensuring that flaws associated with observational studies, other than those due to a lack of randomisation, are minimised.[22]

#### *Eligibility*

To mirror primary care trial recruitment,[18] only those with ≥1 primary care physician claim during the exposure period (7–18 months following the index stroke event) were eligible. To avoid contamination related to receipt of chronic disease management in hospital or rehabilitation settings as part of discharge care planning, our exposure period commenced at seven months post stroke. We excluded registrants who, during the exposure period, were admitted to permanent residential aged care, died, or were admitted to hospital for palliative care. These exclusions were undertaken to reduce survivor bias and address eligibility for the policies of interest (Fig. 1).

#### *Exposure classification*

Participants were classified as exposed if they had ≥1 claim for a new chronic disease management plan or a




*Index stroke event: Date of the first stroke admission recorded in the Australian Stroke Clinical Registry dataset

***Fig. 1:*** **Study time periods.**

claim for a review of a previously established plan during the exposure period (defined by Medicare claim item numbers; Supplemental eTable S2). Participants were defined as unexposed if they did not have a claim for a plan or a review. Data were partitioned by time, with a defined exposure period (Fig. 1). This approach ensured sufficient time for strategies identified in the chronic disease management plan to be implemented within a continuous care model.[22]

*Exposure assignment*

In the absence of randomisation, the IPTW approach was used to minimise confounding. Briefly, a propensity score was generated for each participant based on their probability of having a claim for a chronic disease plan. The propensity score was built using a logistic regression model incorporating 42 covariates (Table 1), known to influence claims for chronic disease management plans or stroke outcomes. IPTWs were then generated to obtain an unbiased estimate of the Average Treatment Effect based on the reciprocal of the probability of receiving the treatment that was actually received (i.e. 1/PS for participants with a claim and 1/(1-PS) for participants without a claim). IPTWs were stabilised, the distribution of weights examined, and extreme weights truncated at the 5th and 95th percentiles. Finally, the balance in baseline covariates between participants with and without a claim in the weighted sample was compared, with an absolute standardised difference (SD) < 0.1 defined as negligible imbalance.

*Follow-up*

Participants were followed from the start of the outcome period (19 months after the index event) to the end of the outcome period (30 months after the index event) or until death, whichever occurred first, to allow sufficient time for strategies identified in the chronic disease management plan to take effect (Fig. 1).

*Outcome measures*

A systematic and blind ascertainment of outcome was ensured through the use of administrative data that are ascertained independent from the primary care physician. Our primary outcome was death from any cause. Secondary outcomes were: a) cumulative rates of hospital presentations per 1000 person-years including analysis of all presentations (non-admitted ED presentations or admissions) and those specific to ED, planned, and unplanned admissions; and b) medication adherence. Medication adherence was assessed as the proportion of days covered (PDC) with adherent defined as ≥80% days covered for antihypertensive, antithrombotic and lipid-lowering medications. The PDC is a proxy measure of medication adherence based on prescription refill patterns and has been shown to have moderate concordance with pill counts.[23] Medication eligibility was adjusted according to type of stroke. See Supplemental eTable S3 for details and reporting of PDC parameters.[24]

*Causal contrasts*

Our primary analysis was based on intention-to-treat. A simulated per protocol analysis was also undertaken in which effect estimates were adjusted for known post baseline prognostic factors associated with adherence to the chronic disease plans.[22] These factors were continuity and regularity of primary care physician contacts during the exposure period, as these are required for optimal delivery of chronic disease management.

## Statistical analysis

*Covariate descriptions and data quality*

Multiple measures were used to maximise data completeness including: harmonisation of hospital data, supplementation of data missing from linked secondary datasets and coding of baseline comorbidities using multiple datasets with a five year look back period from the index event (Supplemental eTable S4).[25] Relevant comorbidities were also combined to derive the Charlson Comorbidity Index.

To avoid overcounting hospital presentations, admission and ED episodes were combined if these were found to have occurred on the same day or had overlapping episode periods.[26] Frequently attended treatment-based services such as chemotherapy, radiotherapy, dialysis and same day or inpatient rehabilitation were excluded.

| | Had a Medicare claim for a chronic disease management plan N = 5556 n (%) | Did not have a Medicare claim for a chronic disease management plan N = 6812 n (%) | P-value |
|---|---|---|---|
| **Patient characteristics**[a] | | | |
| Median (Q1, Q3) age in years | 72.5 (63.0, 79.9) | 67.9 (57.1, 77.3) | <0.001 |
| Female | 2489 (44.8) | 2703 (39.7) | <0.001 |
| Married/partner | 3701 (66.6) | 4510 (66.2) | 0.63 |
| Required an interpreter | 208 (3.7) | 208 (3.1) | 0.03 |
| Lives in regional Australia | 1823 (32.8) | 2252 (33.1) | 0.77 |
| Lives in Queensland | 3143 (56.6) | 3706 (54.4) | 0.02 |
| Socioeconomic advantage[b] | | | |
| Quintile 1 (least advantage) | 1081 (19.5) | 1391 (20.4) | |
| Quintile 2 | 991 (17.8) | 1109 (16.3) | |
| Quintile 3 | 1289 (23.2) | 1417 (20.8) | <0.001 |
| Quintile 4 | 1295 (23.3) | 1495 (22.0) | |
| Quintile 5 (Most advantage) | 900 (16.2) | 1400 (20.6) | |
| Received care concession benefits in the year prior to stroke | 4303 (77.5) | 4164 (61.1) | <0.001 |
| Had private health insurance at stroke admission | 2132 (38.4) | 2683 (39.4) | 0.25 |
| **Acute (index) stroke event details**[a] | | | |
| Year admitted for stroke | | | |
| 2012 | 504 (9.1) | 789 (11.6) | <0.001 |
| 2013 | 1267 (22.8) | 1689 (24.8) | |
| 2014 | 1784 (32.1) | 2128 (31.2) | |
| 2015 | 2001 (36.0) | 2206 (32.4) | |
| Unable to walk on admission | | | |
| Yes | 2413 (43.4) | 2779 (40.8) | 0.01 |
| No | 2810 (50.6) | 3578 (52.5) | |
| Missing | 333 (6.0) | 455 (6.7) | |
| Stroke type | | | |
| Ischaemic | 3482 (62.7) | 4240 (62.2) | |
| Hemorrhagic | 430 (7.7) | 536 (7.9) | 0.96 |
| TIA | 1410 (25.4) | 1741 (25.6) | |
| Not determined | 234 (4.2) | 295 (4.3) | |
| Prior stroke | 1104 (19.9) | 1107 (16.3) | <0.001 |
| Stroke occurred whilst in hospital | 199 (3.6) | 192 (2.8) | 0.02 |
| Treated in a stroke unit | 4515 (81.3) | 5449 (80.0) | 0.08 |
| Received inpatient rehabilitation | 1832 (33.0) | 1815 (26.6) | <0.001 |
| Comorbidities (based on hospital admissions ≤5 years of the index stroke admission) | | | |
| Hypertension | 4080 (73.4) | 4139 (60.8) | <0.001 |
| Dyslipidaemia | 3584 (64.5) | 3403 (50.0) | <0.001 |
| Atrial fibrillation | 1311 (23.6) | 1340 (19.7) | <0.001 |
| Angina | 1032 (18.6) | 918 (13.5) | <0.001 |
| Diabetes mellitus | 1849 (33.3) | 1169 (17.2) | <0.001 |
| Smoking | 3098 (55.8) | 3745 (55.0) | 0.38 |
| Obesity | 203 (3.7) | 179 (2.6) | <0.01 |
| Cancer | 378 (6.8) | 430 (6.3) | 0.27 |
| Liver disease | 117 (2.1) | 134 (2.0) | 0.59 |
| Renal disease | 600 (10.8) | 504 (7.4) | <0.001 |
| Heart failure | 522 (9.4) | 458 (6.7) | <0.001 |
| Myocardial infarction | 497 (9.0) | 479 (7.00) | <0.001 |
| COPD | 398 (7.2) | 337 (5.0) | <0.001 |
| Peripheral vascular disease | 318 (5.7) | 303 (4.5) | 0.001 |
| Mental health problems | 261 (4.7) | 292 (4.3) | 0.27 |

(Table 1 continues on next page)

| | Had a Medicare claim for a chronic disease management plan N = 5556 n (%) | Did not have a Medicare claim for a chronic disease management plan N = 6812 n (%) | P-value |
|---|---|---|---|
| (Continued from previous page) | | | |
| Dementia | 104 (1.9) | 111 (1.6) | 0.31 |
| Alcohol | 240 (4.3) | 348 (5.1) | 0.04 |
| Median (Q1, Q3) CCI score | 2.0 (0, 3.0) | 2.0 (0, 2.0) | <0.001 |
| **Community based care**[a] | | | |
| Regularly saw their primary care physician regularly (24 months prior to stroke)[c] | 4711 (84.8) | 4647 (68.2) | <0.001 |
| Consistently saw the same primary care physician (continuity 24 months prior to stroke)[d] | 1278 (23.0) | 1590 (23.3) | 0.66 |
| Neurology visit[e] | 1778 (32.0) | 2288 (33.6) | 0.06 |
| Outpatient cardiology visit[e] | 1866 (33.6) | 2242 (32.9) | 0.43 |
| Outpatient rehabilitation physician visit[e] | 644 (11.6) | 687 (10.1) | 0.01 |
| **Medication dispensed >1 in the first 6 months following stroke**[a] | | | |
| Non-aspirin antithrombotics (excludes ICH) | 4635 (83.4) | 5286 (77.6) | <0.001 |
| Lipid-lowering | 4880 (87.8) | 5625 (82.6) | <0.001 |
| Antihypertensives | 4797 (86.3) | 5272 (77.4) | <0.001 |
| **Chronic disease management Medicare claim during the exposure period** | | | |
| Mean number of chronic disease plans or reviews claimed (SD) | 1.6 (0.8) | 0 (0) | <0.001 |
| Had a claim for coordinated multidisciplinary care[f] | 2813 (50.6) | 413 (6.1) | <0.001 |
| One or more allied health claims[g] | 4833 (87.0) | 4300 (63.1) | <0.001 |
| Timing of first chronic disease claim or review during the exposure period | | | |
| 1st quartile | 2143 (38.6) | – | <0.001 |
| 2nd quartile | 1620 (29.2) | – | |
| 3rd quartile | 1003 (18.1) | – | |
| 4th quartile | 790 (14.2) | – | |

Q1: quartile 1, Q3: quartile 3; SD: Standard Deviation, TIA: Transient Ischaemic Attack, CCI: Charlson Comorbidity Index, COPD: Chronic Obstructive Pulmonary Disease. Data are summarised as frequencies and proportions except otherwise stated. P-values were obtained by Wilcoxon rank sum tests for continuous variables and $\chi^2$ tests for categorical variables. [a]Included in the generation of the propensity score. [b]Derived from the Index of Relative Social Advantage and Disadvantage with predefined categories developed by the Australian Bureau of Statistics based on residential postcodes. [c]Based on no gaps longer than 6 months between encounters. [d]Based on a Continuity of Care Index score ≥80%. [e]In the first 6 months following stroke. [f]Claimed services from a primary care physician and at least two types of allied health professionals. [g]Services includes those funded through Medicare: physiotherapy, podiatry, exercise physiology, dietetics, audiology, chiropractor, diabetes education, mental health worker, osteopathy and psychology.

***Table 1:*** **Baseline characteristics of participants who did and did not have a Medicare chronic disease management claim in the 7–18 months following stroke.**

Regularity of visits with primary care physicians within the two years prior to stroke was defined as a measure of the distribution of primary care physician service utilisation over time and used to adjust for baseline regularity.[27]

*Primary and secondary analyses*

We fitted multi-level mixed-effects Cox proportional hazard and logistic regression models, with the patient and health service region as nested random effects. Models were weighted using IPTW, with year as a covariate. Assumptions of proportional hazards were confirmed for the Cox models. The significance level was set at 2-sided $P \leq 0.05$. All statistical analyses were undertaken using STATA/MP 16.0 for Windows (StataCorp, College Station, TX, USA, 2019).

*Sensitivity and subgroup analyses*

Prespecified variables were tested for any interaction or modification effect with the exposure on survival by inserting product (interaction) terms into primary outcome models. Subgroup analyses were also conducted for: regularity of visits to primary care physician (in the 24 months prior to stroke); new claims vs no claim; ≥2 claims vs no claim; stroke vs TIA; multimorbidity (1 and 2, ≥3 chronic conditions other than stroke) vs single morbidity; age group (<65, 65–74, 75–84, 85+ years); sex; stroke severity; prior stroke; atrial fibrillation; hypertension; and diabetes. To further test the robustness of our results we undertook a quantitative analysis of potential biases arising from the misclassification (differential and non-differential) of participants into the exposure groups on the primary

outcome. This misclassification may be due to insufficient documentation or the management plans not being delivered in the way intended. Bias parameters were specified based on expert opinion[28] on the likelihood of misclassification. For non-differential misclassification of having a claim, we specified the same hypothetical range of errors for misclassification in participants who died and those who survived, i.e. specificity and sensitivity values between 0.75 and 1.00. For differential misclassification, we specified error values of 0.75–1.00 for participants who died, and 0.70–1.00 for those who survived, and a between-group correlation in sensitivity and specificity values of 0.8. This process was repeated 1000 times to obtain simulated distribution of hazard ratios corrected for systematic errors.

### Role of funding source

The study funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

## Results

Of the 28,775 AuSCR registrants from Victoria or Queensland who were eligible for data linkage, 27,435 (95.3%) were successfully linked with the administrative datasets (Supplementary eFig. S1). Of these 12,368 met our eligibility criteria (Fig. 2) and 93.6% had complete data. Median age was 70.2 years (quartile 1: 59.9, quartile 378.7), 42.0% were female and 25.6% experienced a TIA. Overall 75.7% saw their primary care physician regularly and 44.9% had a Medicare claim for chronic disease management during the exposure period. During the outcome period 3.7% transitioned to permanent residential care with a greater proportion observed in the chronic disease management group (4.6% vs 2.9%).

Prior to applying IPTWs, baseline characteristics and risk factors differed between those who did and did not have a Medicare claim for chronic disease management. Participants who: regularly saw their primary care physicians prior to stroke, had a concession that provides additional subsidies for health care, or had diabetes, more often had a claim for chronic disease management than those who did not (Table 1). Following the application of IPTWs, excellent balance was achieved between groups (Fig. 3). During the follow-up period we observed 516 (4.17%) deaths and 16,681 hospital presentations, of which 10,675 (64.0%) were unplanned and 6006 (36.0%) planned (e.g. elective surgery, planned treatments).

In weighted multivariable models, participants with a claim for chronic disease management had a 26% lesser mortality rate during the follow-up period, adjusted hazard ratio (aHR): 0.74 (95% confidence interval [CI]: 0.62, 0.87) compared to those without a claim (Table 2). Results remained similar for the per protocol analysis. On systematic bias analysis, the effect of the exposure on survival was stronger for assumptions of non-differential (HR: 0.66, 95% CI: 0.53, 0.80) or differential misclassification (HR: 0.69, 95% CI: 0.45, 1.02)

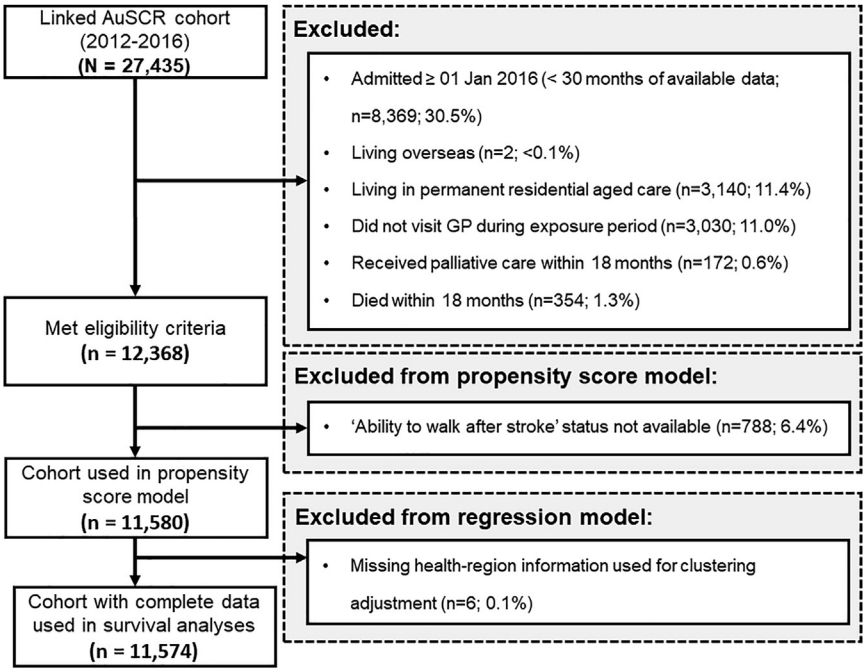



*Fig. 2:* **Study flow diagram.**

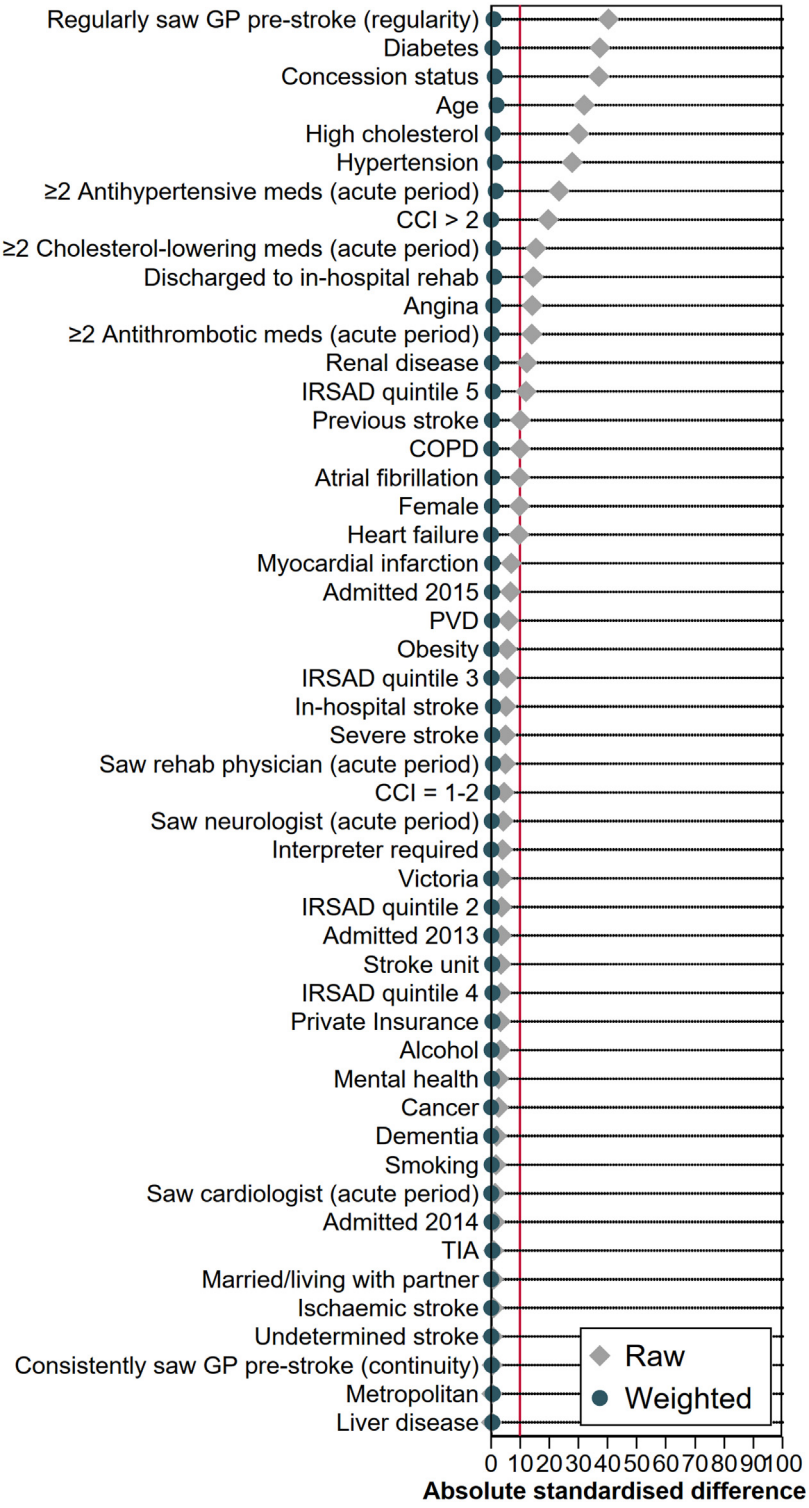



*Fig. 3:* **Standardised differences in baseline covariates between those with and without a chronic disease management claim pre and post application of inverse probability treatment weights.**

| | Cumulative incidence rate[a] | | | | |
|---|---|---|---|---|---|
| | Had a Medicare claim for a chronic disease management plan N = 6357 | | Did not have a Medicare claim for a chronic disease management plan N = 5223 | | Weighted Model[a] HR (95% CI) |
| | Events | Rate | Events | Rate | |
| **Primary outcome** | | | | | |
| Deaths | 223 | 0.112 | 293 | 0.120 | 0.74 (0.62, 0.87) |
| **Secondary outcome 1—hospital presentations** | | | | | |
| All presentations | 8863 | 1729.9 | 7818 | 1256.0 | 1.17 (1.13, 1.21) |
| Admissions only | 6939 | 1354.3 | 6086 | 977.7 | 1.15 (1.10, 1.21) |
| Unplanned | 3758 | 733.5 | 3261 | 523.9 | 1.10 (1.00, 1.21) |
| Planned | 3181 | 620.9 | 2825 | 453.8 | 1.21 (1.13, 1.31) |
| ED presentations only | 1924 | 375.5 | 1732 | 278.2 | 1.23 (1.13, 1.35) |
| **Secondary outcome 2—medication adherence** | | | | | |
| | n/N | % | n/N | % | Weighted Model[a] OR (95% CI) |
| Non-aspirin Antithrombotics[b] | 2536/4825 | 52.6 | 2475/5878 | 42.1 | 1.16 (1.07, 1.26) |
| Lipid-lowering | 2991/5223 | 57.3 | 2917/6357 | 45.9 | 1.23 (1.13, 1.33) |
| Antihypertensives | 2945/5223 | 56.4 | 2969/6357 | 46.7 | 1.16 (1.07, 1.25) |

ED: emergency department, CI: Confidence Interval, HR: Hazard Ratio, OR: Odds Ratio. [a]Models weighted using inverse probability treatment weights with year as a covariate. [b]Excludes patients with intracerebral haemorrhage.

*Table 2:* **Primary and secondary outcome results.**

(Supplemental eTable S5). In the stratified analyses, we were unable to detect statistically significant differences in survival for any subgroup (Table 3). However, new users and those with more than one claim during the exposure period demonstrated a greater benefit than those who had a claim prior to their stroke or only one claim during the exposure period (Table 4).

There was an overall 17% greater rate of presenting to the hospital (ED presentations and admissions) in those with a chronic disease management claim compared to those without (aHR: 1.17, 95% CI: 1.13, 1.21; Table 2). When examined separately there was a 23% increase for ED presentations that did not result in an admission (aHR: 1.23, 95% CI: 1.13, 1.35) and a 15% increase for admissions (aHR: 1.15, 95% CI: 1.10, 1.21). When examined further, there was a non-significant 10% increase in rates of unplanned admissions (aHR: 1.10, 95% CI: 1.00, 1.21) and 21% increase in rates of planned admissions (aHR: 1.21, 95% CI: 1.13, 1.31). ED presentation rates did not differ when stratified by high vs low acuity (Table 2). Hospital presentation rates due to cardiovascular disease, chest pain/collapse and abnormal findings were greater in those with a chronic disease management claim compared to those without (Fig. 4). All models met the assumptions for proportional hazards.

A greater proportion of those with a chronic disease management claim were adherent to non-aspirin antithrombotic (83.4% vs 77.6%), lipid-lowering (87.8% vs 82.6%) and antihypertensive medication (86.3% vs 77.4%), compared to those without. In weighted multivariable models, those with a chronic disease management claim had a greater odds of being adherent (PDC ≥ 80) for all three prevention medication types, compared to those without a claim (Table 2).

## Discussion

Our findings provide evidence of population effectiveness of Australian Medicare-funded chronic disease management policies in primary care for improving the long-term survival of people living with stroke/TIA and adherence to secondary prevention medication. Impacts on planned admissions and ED-only presentations are less clear. Despite the survival benefits, less than half of our cohort had a chronic disease management claim.

As all people who suffer a stroke/TIA have an elevated risk of subsequent cardiovascular events, all are eligible for these plans.[2] However, less than half of our cohort had a chronic disease management claim. This is similar to other chronic conditions, such as chronic lung disease (49%) and heart disease (47%), and suggests suboptimal uptake generally within primary care.[21] This is despite a gradual population increase in access by people aged ≥65 years from 86.25 services per 100 people in 2013/14 to 129.30 services per 100 people in 2020/2021.[29,30] Our results support the effectiveness of these policies at a population level, above that of standard care, to promote the use of these plans.

In recognition of the rising prevalence and healthcare costs associated with chronic diseases, governments have implemented policy initiatives that provide financial incentives to providers to deliver comprehensive chronic disease management. In our study, these incentives were provided through specific Medicare claim

| Subgroup stratification | Total = 11,574 N (%) | Hazard Ratio (95% CI) | Interaction P-Value |
|---|---|---|---|
| Regularity of visits to PCP | | | |
| Regular ( ≥ 1 visit/6 months)[a] | 8756 (75.7) | 0.75 (0.61, 0.91) | 0.68 |
| Irregular | 2818 (24.3) | 0.67 (0.42, 1.06) | |
| CDMP claim prior to stroke[b] | | | |
| Yes | 3940 (34.0) | 0.59 (0.45, 0.77) | 0.69 |
| No | 7634 (66.0) | 0.66 (0.44, 0.97) | |
| Age group, years | | | |
| <65 | 4229 (36.5) | 0.62 (0.35, 1.08) | Ref |
| 65–7 | 3132 (27.1) | 0.94 (0.69, 1.27) | 0.22 |
| 75–84 | 3196 (27.6) | 0.77 (0.61, 0.97) | 0.46 |
| ≥85 | 1017 (8.8) | 0.61 (0.37, 1.00) | 0.95 |
| Type of index event | | | |
| Hemorrhagic/ischaemic stroke | 7239 (62.5) | 0.76 (0.65, 0.88) | 0.93 |
| TIA | 3149 (27.2) | 0.78 (0.51, 1.18) | |
| Prior stroke | | | |
| Yes | 2119 (18.3) | 0.65 (0.47, 0.89) | 0.42 |
| No | 9455 (81.7) | 0.77 (0.62, 0.94) | |
| Unable to walk on admission | | | |
| Yes | 5190 (44.8) | 0.72 (0.53, 0.96) | 0.82 |
| No | 6384 (55.2) | 0.76 (0.57, 1.01) | |
| Sex | | | |
| Women | 4871 (42.1) | 0.66 (0.48, 0.91) | 0.37 |
| Men | 6703 (57.9) | 0.79 (0.65, 0.96) | |
| Lives in regional Australia | | | |
| Yes | 3785 (32.7) | 0.77 (0.60, 0.98) | 0.69 |
| No | 7789 (67.3) | 0.72 (0.59, 0.89) | |
| Outpatient neurology visit[c] | | | |
| Yes | 3825 (33.0) | 0.76 (0.54, 1.06) | 0.92 |
| No | 7749 (67.0) | 0.73 (0.56, 0.95) | |
| Outpatient cardiology visit[c] | | | |
| Yes | 3865 (33.4) | 0.87 (0.67, 1.12) | 0.07 |
| No | 7709 (66.6) | 0.69 (0.57, 0.83) | |
| Had diabetes[d] | | | |
| Yes | 2836 (24.5) | 0.62 (0.45, 0.85) | 0.30 |
| No | 8738 (75.5) | 0.80 (0.62, 1.04) | |
| Had hypertension[d] | | | |
| Yes | 7666 (66.2) | 0.71 (0.62, 0.82) | 0.30 |
| No | 3908 (33.8) | 0.83 (0.59, 1.16) | |
| Had atrial fibrillation[d] | | | |
| Yes | 2483 (21.5) | 0.81 (0.66, 0.98) | 0.36 |
| No | 9091 (78.5) | 0.70 (0.55, 0.89) | |
| Number of comorbidities[d,e] | | | |
| None | 2388 (36.1) | 0.93 (0.62, 1.38) | Ref |
| 1–2 | 5008 (43.3) | 0.77 (0.61, 0.99) | 0.36 |
| ≥3 | 4178 (20.6) | 0.62 (0.50, 0.78) | 0.07 |

PCP: primary care physician, CDMP: Chronic Disease Management Plan, TIA: Transient Ischaemic Attack. [a]Within two years prior to stroke. [b]Within one year prior to stroke. [c]In the 0–6 months post stroke. [d]Within five years prior to stroke (including the index stroke admission). [e]As defined by the Charlson Comorbidity Index.

***Table 3:*** **Subgroup analysis results for the primary outcome of survival.**

items that attracted additional reimbursement above that of a standard consultation. Evidence from other research on the effectiveness of financial incentives in primary care is conflicting, with the clearest benefit likely related to improving adherence to clinical indicators or processes of care. Existing data are limited on whether these plans improve long-term patient outcomes.[31,32] Improved prescribing has also been demonstrated in response to financial incentives.[32] The differences in uptake of medications observed between groups may be

| | Total cohort (n = 12,368) n (%) | Analysis cohort (n = 11,574) n (%) | HR (95% CI) | P-value |
|---|---|---|---|---|
| Number of claims for a chronic disease management plan or review in the 7–18 months following stroke | | | | |
| 0 | 6812 (55.1) | 6356 (54.9) | Ref | |
| 1 | 3209 (26.0) | 3018 (26.1) | 0.76 (0.62, 0.93) | 0.01 |
| ≥2 | 2347 (19.0) | 2200 (19.0) | 0.70 (0.57, 0.88) | <0.01 |
| Prior and current chronic disease management claims | | | | |
| No pre or post stroke claim | 6812 (55.1) | 6356 (54.9) | Ref | |
| Pre and post stroke claim[a] | 3689 (29.8) | 3472 (30.0) | 0.88 (0.75,1.02) | 0.09 |
| Post stroke claim only (new user)[b] | 1867 (15.1) | 1746 (15.1) | 0.53 (0.35, 0.81) | <0.01 |

[a]Had a chronic disease management claim within the exposure (7–18 months following stroke) and in the 2-years pre-stroke. [b]Had a chronic disease management claim within the exposure period (7–18 months following stroke) but not the 2-year pre-stroke period.

***Table 4:*** **Sensitivity analysis for the primary outcome of survival, based on claim usage patterns.**

explained by perceived side effects. We hypothesise that receipt of more comprehensive cardiovascular risk assessment and medication counselling provided through chronic disease management claims may have supported adherence to these medications. Our results support this hypothesis as evidenced by improvements in observed adherence to prevention medications.

Incentivising the coordination of multidisciplinary care through chronic disease management may also have contributed to improved outcomes in our study. There is emerging evidence of the effectiveness of complex, low-cost patient-oriented interventions that focus on the broader context of recovery and cardiovascular risk control delivered through primary and community care.[9,33,34] Similarly, organisational interventions that utilised multidisciplinary team approaches with regular patient appointments have been associated with the greatest reductions in blood pressure.[6] Our stratified results also indicate that the survival benefit is applicable to most groups living with stroke/TIA.

Results pertaining to hospital presentations in our study were mixed with an overall increase amongst those with a chronic disease management claim. Factors influencing hospital admissions in the long-term following stroke are multifactorial[26] and in some circumstances may be due to unmet health needs being identified during the care planning process.[9] Reasons for the increase in ED presentations, that did not result in an admission, are also consistent with other national and international studies[35,36] Specific to stroke, the use of structured plans and collaborative goal setting to manage chronic diseases related to cardiovascular risk (e.g. hypertension, atrial fibrillation, hyperlipidemia), may have led to increased surveillance of cardiovascular signs prompting an increase in ED presentations.[35] From an economic perspective this trade-off between

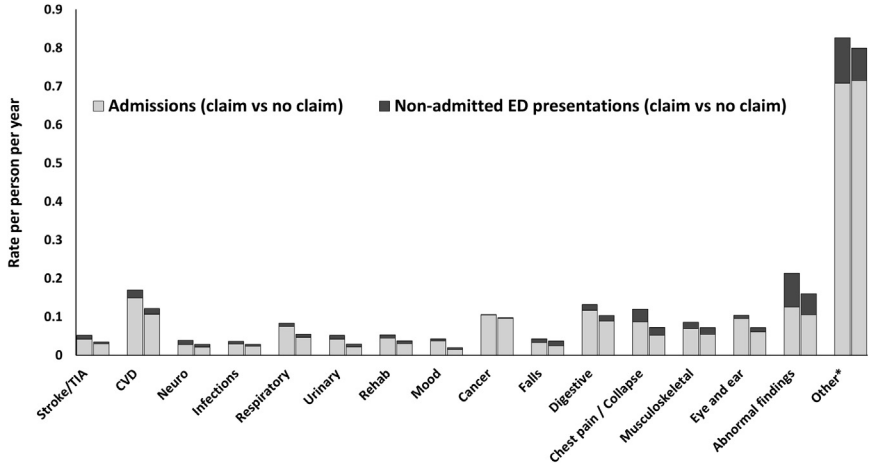



***Fig. 4:*** **Rates per person per year of hospital presentations according to the primary cause of hospital presentations in the 19–30 months following stroke, stratified by the presence or absence of a chronic disease management claim in the 7–18 months following stroke.** TIA indicates transient ischemic attack, CVD indicates cardiovascular disease (excluding stroke) and Rehab indicates rehabilitation services. * Includes 3.7% of non-admitted ED presentations that did not have a primary diagnosis code.

hospital presentations and survival increases the overall system costs. However, this may be considered acceptable by government and society given the observed survival benefits. System factors that may also influence hospital utilisations include: lack of timely access to primary care physicians as a result of wait lists or limited after hours services, geographic remoteness or out of pocket expenses above the Medicare rebate (particularly for those without concession cards), as ED does not incur a cost to the patient. Nevertheless, our results highlight the need for financially-based policies such as these to be implemented within the context of broader health system redesign.[36]

Strengths of our study include our large linked population dataset with a clinical diagnosis of stroke or TIA. The size and breadth of data enabled successful emulation of a target trial, allowing explicit description of key components of our study design in such a way as to avoid biases that commonly occur when drawing causal inferences from observational data. Further, we were able to obtain reliable estimates of the average treatment effect over the entire population through the application of IPTWs. In doing so we maintained strong external validity which is of particular interest for policy-relevant exposures such as those in our study.

There are several limitations to our study. Although we were able to demonstrate better adherence to secondary prevention medication in those with a chronic disease management claim, we were not able to discern the content of the plans or the extent to which they promoted self-management. We included a number of standard social and economic measures in our study. However, explanatory variables related to health seeking behaviours such as health literacy, self-efficacy or service accessibility were not able to be accounted for in the analysis. Medication adherence was based on dispensing histories and it was not possible to verify whether these medications were taken. We were also unable to account for medications supplied in hospital or without a prescription (e.g. aspirin). However, all medications relevant to our study are captured through the Australian pharmaceutical dispensing dataset. We have used multiple rigorous approaches to control for confounding and bias through the emulated target trial approach, used IPTW to reduce bias for 42 baseline variables and used truncation of IPTWs to meet assumptions of positivity. As this study was observational, and therefore did not involve randomisation of participants, we cannot discount the possibility of residual confounding due to unmeasured variables. Restrictions imposed through the target trial emulation, may limit generalisability to those who survive the first 18 months following stroke, are living in the community and are under the care of a primary care physician. Our exclusion of participants who transitioned to residential care also means that our final sample contained a lesser proportion of female and older participants than is generally observed in population-based stroke studies.

## Conclusion

Our findings have important implications for promoting the benefits of chronic disease management policy in primary care of people living with stroke/TIA. We provide evidence of survival benefits afforded by government policies that financially support primary care physicians to provide structured chronic disease management in the long-term management of stroke/TIA. We also provide a strong case for the ongoing provision of these plans within a universal healthcare system, despite an observed increase in overall hospital presentations. Strategies to improve uptake at the primary care level are needed and could include: greater financial incentives and mandates, education for patients and healthcare professionals, and ongoing population monitoring involving audit and feedback. Future research is needed to understand nuances associated with uptake from both a provider and patient perspective.

### Contributors

NEA, MFK, JK, LC, AGT, VS, DAC, MRN, NAL and VSr contributed to the study design, inception and statistical analysis plan for the study. NEA, MFK had full access to all of the study data and oversaw the data acquisition, cleaning, management and analysis which was undertaken by MTO, DU, LLD and RB. NEA led the writing of the original draft with assistance from DU, MTO, LLD and MK. All authors contributed to interpretation of the data and provided revision of the manuscript for critically important intellectual content. All authors read and approved the final version of the manuscript.

### Data sharing statement

Due to ethical and legal restrictions associated with access to government administrative data, person level data from this study cannot be shared. However, certain aggregated data outputs as well as coding and data dictionaries that support the findings of this study are available from the corresponding author on reasonable request and with approval from the relevant data custodians.

### Ethical approval

The Monash University Human Research Ethics Committee (MUHREC/12301) and the Australian Institute of Health and Welfare ethics committee (EO2018/2/449) provided ethical approval for this study. Approvals were also obtained from the AuSCR Research Task Group and the data custodian responsible for each of the government datasets.

### Declaration of interests

DAC reports funding from Boehringer Ingelheim, Ipsen, Amgen, and Medtronic and LLD from GKS with funds paid to their institution. DAC is the Data Custodian for the AuSCR and Executive Officer, Stroke Society of Australasia. AGT reports prior membership of the AuSCR Steering Committee. MFK and NAL, report membership of the AuSCR Management Committee and NEA reports membership of the AuSCR Research Task Group. MRN reports membership of a Novartis lipids advisory board. All other authors report no potential conflicts of interest with respect to the research, authorship, or publication of this article.

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### Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2023.100723.

### References

1 Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1204–1222.
2 Mohan KM, Wolfe CD, Rudd AG, Heuschmann PU, Kolominsky-Rabas PL, Grieve AP. Risk and cumulative risk of stroke recurrence: a systematic review and meta-analysis. *Stroke*. 2011;42(5):1489–1494.
3 Gallacher KI, Jani BD, Hanlon P, Nicholl BI, Mair FS. Multimorbidity in stroke. *Stroke*. 2019;50(7):1919–1926.
4 Zonneveld TP, Richard E, Vergouwen MD, et al. Blood pressure-lowering treatment for preventing recurrent stroke, major vascular events, and dementia in patients with a history of stroke or transient ischaemic attack. *Cochrane Database Syst Rev*. 2018;7:CD007858.
5 Manktelow BN, Potter JF. Interventions in the management of serum lipids for preventing stroke recurrence. *Cochrane Database Syst Rev*. 2009;3:CD002091.
6 Bridgwood B, Lager KE, Mistri AK, Khunti K, Wilson AD, Modi P. Interventions for improving modifiable risk factor control in the secondary prevention of stroke. *Cochrane Database Syst Rev*. 2018;5:CD009103.
7 Deijle IA, Van Schaik SM, Van Wegen EE, Weinstein HC, Kwakkel G, Van den Berg-Vos RM. Lifestyle interventions to prevent cardiovascular events after stroke and transient ischemic attack: systematic review and meta-analysis. *Stroke*. 2017;48(1):174–179.
8 Dalli LL, Kim J, Thrift AG, et al. Patterns of use and discontinuation of secondary prevention medications after stroke. *Neurology*. 2021;96(1):e30–e41.
9 Smith SM, Wallace E, O'Dowd T, Fortin M. Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *Cochrane Database Syst Rev*. 2016;3:CD006560.
10 Andrew N, Kilkenny M, Naylor R, et al. Understanding long-term unmet needs in Australian survivors of stroke. *Int J Stroke*. 2014;9:106–112.
11 Lewis R, Dixon J. Rethinking management of chronic diseases. *BMJ*. 2004;328(7433):220–222.
12 Dennis SM, Zwar N, Griffiths R, et al. Chronic disease management in primary care: from evidence to policy. *Med J Aust*. 2008;188(S8):S53–S56.
13 Harris MF, Harris-Roxas B, Knight AW. Care of patients with chronic disease: achievements in Australia over the past decade. *Med J Aust*. 2018;209(2):55–57.
14 Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. *JAMA*. 2002;288(15):1909–1914.
15 Stroke Foundation. *Clinical Guidelines for Stroke Management*. Melbourne, Australia: Stroke Foundation; 2022.
16 Brotons C, Soriano N, Moral I, et al. Randomized clinical trial to assess the efficacy of a comprehensive programme of secondary prevention of cardiovascular disease in general practice: the PREseAP study. *Rev Esp Cardiol*. 2011;64(1):13–20.
17 Fukuoka Y, Hosomi N, Hyakuta T, et al. Effects of a disease management program for preventing recurrent ischemic stroke. *Stroke*. 2019;50(3):705–712.
18 Olaiya MT, Kim J, Nelson MR, et al. Effectiveness of a shared team approach between nurses and doctors for improved risk factor management in survivors of stroke: a cluster randomized controlled trial. *Eur J Neurol*. 2017;24(7):920–928.
19 Cadilhac DA, Lannin NA, Anderson CS, et al. Protocol and pilot data for establishing the Australian stroke clinical registry. *Int J Stroke*. 2010;5(3):217–226.
20 Australian Bureau of Statistics. *National, state and territory population*; 2022. Published 2022. https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/latest-release. Accessed January 3, 2023
21 Australian Institute of Health and Welfare. *Use of Medicare chronic disease management items by patients with long-term health conditions, catalogue number PHC 7*. Canberra, Australia: AIHW, Australian Government; 2022.
22 Hernan MA, Robins JM. Using big data to emulate a target trial when a randomized trial is not available. *Am J Epidemiol*. 2016;183(8):758–764.
23 Grymonpre R, Cheang M, Fraser M, Metge C, Sitar DS. Validity of a prescription claims database to estimate medication adherence in older persons. *Med Care*. 2006;44(5):471–477.
24 Dalli LL, Kilkenny MF, Arnet I, et al. Towards better reporting of the Proportion of days covered method in cardiovascular medication adherence: a scoping review and new tool TEN-SPIDERS. *Br J Clin Pharmacol*. 2022;88(10):4427.
25 Kilkenny MF, Dalli LL, Sanders A, et al. Comparison of comorbidities of stroke collected in administrative data, surveys, clinical trials and cohort studies. *Health Inf Manag*. 2022. https://doi.org/10.1177/18333583221124371.
26 Andrew NE, Kilkenny MF, Sundararajan V, et al. Hospital presentations in long-term survivors of stroke: causes and associated factors in a linked data study. *Stroke*. 2020;51(12):3673–3680.
27 Ung D, Wang Y, Sundararajan V, et al. Optimal measures for primary care physician encounters after stroke and association with survival: a data linkage study. *Neuroepidemiology*. 2022;56(2):90–96.
28 Lash T, Fox M, Fink A. *Presentation and inference. Applying quantitative bias analysis to epidemiologic data*. New York, NY: Springer; 2009.
29 AIHW Australian Institute of Health and Welfare. *Medicare-subsidised GP, allied health and specialist health care across local areas: 2013–14 to 2017–18*. Canberra, Australia: Australian Institute of Health and Welfare; 2019.
30 Australian Institute of Health and Welfare. *Medicare-subsidised GP, allied health and specialist health care across local areas: 2021–22*. Canberra, Australia: Australian Institute of Health and Welfare; 2022.
31 Yuan B, He L, Meng Q, Jia L. Payment methods for outpatient care facilities. *Cochrane Database Syst Rev*. 2017;3:CD011153.
32 Mendelson A, Kondo K, Damberg C, et al. The effects of pay-for-performance programs on health, health care use, and processes of care: a systematic review. *Ann Intern Med*. 2017;166(5):341–353.
33 Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet*. 2012;380(9836):37–43.
34 Fu V, Weatherall M, McPherson K, et al. Taking charge after stroke: a randomized controlled trial of a person-centered, self-directed rehabilitation intervention. *Int J Stroke*. 2020;15(9):954–964.
35 Xia T, Enticott J, Pearce C, Mazza D, Turner LR. Predictors of ED attendance in older patients with chronic disease: a data linkage study. *Aust Health Rev*. 2020;44(4):550–556.
36 Lavergne MR, Law MR, Peterson S, et al. Effect of incentive payments on chronic disease management and health services use in British Columbia, Canada: interrupted time series analysis. *Health Policy*. 2018;122(2):157–164.