Victorian Agency for Health Information

Delivering better cardiac outcomes in Victoria

An initiative of the National Data Linkage Demonstration Project

June 2019

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Victorian Agency for Health Information

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Victorian Cardiac Clinical Network, Safer Care Victoria
Centre for Big Data Research in Health, UNSW Sydney

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The National Data Linkage Demonstration Project Steering Committee members for their national oversight and support of this initiative.

About the Victorian Agency for Health Information

The Victorian Agency for Health Information (VAHI) is an Administrative Office of the Department of Health and Human Services.

VAHI analyses and shares information across the Victorian health system to ensure services have an accurate picture of their quality and safety.

VAHI monitors and reports on public and private services that impact on health, wellbeing, quality and safety in order to stimulate and inform improvements, increase transparency and accountability, and inform the community.

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Executive summary

Introduction

This report has been developed by the Victorian Agency for Health Information (VAHI) in collaboration with Centre for Big Data Research in Health, UNSW Sydney, Safer Care Victoria, and the Cardiac Clinical Network of the NSW Agency for Clinical Innovation, as part of the Delivering better cardiac outcomes: Primary, specialist and hospital care project ('the project'), which is an initiative under the National Data Linkage Demonstration Project (NDLDP).

The NDLDP brings together over 7 billion records of health data for over 10 million individuals from NSW and Victoria over 5 years in a linked database. This report presents results for 33,806 patients hospitalised for atrial fibrillation (AF) and 10,639 patients hospitalised for acute myocardial infarction (AMI) in Victoria.

This is the first time in Australia that population-level linked Commonwealth and State health data have been used to describe the journey of AF and AMI patients from hospital admission through to discharge and post-discharge.

Results

The results presented in this report show that use of both oral anticoagulants (OACs) in AF patients and adenosine diphosphate (ADP) receptor antagonists in AMI patients in the month after discharge is low (30.4% and 53.9%, respectively), despite being considered best-practice.

Furthermore, there is significant variation in dispensing rates between Victorian hospitals for both conditions, ranging from 22% to 40% for OACs in AF patients and 22% to 74% for ADP receptor antagonists in AMI patients, at 30 days post-discharge.

Implications for practice

Improving post-discharge dispensing rates of these medicines could reduce rates of stroke, myocardial infarction, and death in high-risk cardiac patients. Focusing on variation in care, and strategies to reduce it, can help ensure everyone is receiving high quality care.

This project demonstrated that data linkage can enable evaluation of patient care pathways across both hospital and community-based services. Linked data provide essential information to identify evidence-practice gaps and investigate variation in care in Australia. The findings can be used to drive quality improvement in cardiac care across the Victorian health system.

Further work is required to determine the factors influencing the lower than expected dispensing rates and the observed variation by hospital of discharge. Further development of the linked database would only add value to the utility of the project.

Introduction

This report has been developed as part of the Delivering better cardiac outcomes: Primary, specialist and hospital care project ('the project'), an initiative under the National Health Information and Performance Principle Committee (NHIPPC) National Data Linkage Demonstration Project (NDLDP).

The project was commissioned by the Victorian Agency for Health Information (VAHI). It is a collaboration between the Victorian Government (through VAHI), the Centre for Big Data Research in Health, UNSW Sydney, Safer Care Victoria, and the Cardiac Clinical Network of the NSW Agency for Clinical Innovation.

The project was established to drive improvements in cardiac care and health outcomes by producing practice-relevant, high quality information about patient journeys through the healthcare system.

This report details the findings from two areas of investigation:

- Use of oral anticoagulants in atrial fibrillation (AF)
- Use of dual antiplatelet therapy in acute myocardial infarction (AMI).

This is the first time in Australia that population-level linked Commonwealth and State health data have been used to describe the journey of patients with AF and AMI from hospital admission through to discharge and post-discharge.

The two investigations are presented separately in this report as they contain slight differences in methodology and results due to differences in data and the clinical population.

While the project included results for Victoria and New South Wales, this report presents Victorian results only.

National Data Linkage Demonstration Project

> The National Data Linkage Demonstration Project (NDLDP) was established in response to a request by the Australian Health Ministers Advisory Council (AHMAC). The project is designed to provide advice on the feasibility, benefits and accountabilities of common and enduring arrangements that could be adopted for multi-jurisdictional data linkage, including access to and use of this data.
>
> The NDLDP brings together public hospital admitted patient care data from NSW and Victoria, with Medicare Benefits Schedule (MBS) data, Pharmaceutical Benefits Scheme (PBS) data and National Death Index (NDI) data. The linked database includes 7 billion records of health data for over 10 million individuals over 5 years. It is intended to be a source of patient-centred information that defines the patient journey through the health system, allowing assessments of the efficacy and effectiveness of the health services that patients access.
>
> Data linkage for the NDLDP was undertaken by the Australian Institute of Health and Welfare (AIHW).

Use of oral anticoagulants in atrial fibrillation

Introduction

The aim of this investigation is to describe rates of oral anticoagulant (OAC) dispensing among people hospitalised for atrial fibrillation (AF) in a Victorian public hospital from July 2011 to December 2013 using population-level linked data. AF is a common condition that increases the risk of stroke nearly fivefold,[1] and is associated with substantial health system costs.[2] In 2014, there were an estimated 330,000 people aged 55 years or older living with AF in Australia, with projections for this number to nearly double by 2034.[3] Rates of AF increase with age, occurring in an estimated 5.4% of people 55 and older, and 17.6% of people 85 years and older.[3]

Stroke in people with AF is potentially preventable with the use of OAC therapy. Warfarin (a vitamin K antagonist) reduces the risk of stroke in people with AF by 61%,[4] however, it carries an increased risk of bleeding and intracranial haemorrhage that may not be offset by its benefits for some individuals.[5] Traditionally, AF patients were primarily treated with warfarin, but in the last 5 years non-vitamin K antagonist OACs (NOACs: apixaban, dabigatran, rivaroxaban) have been registered and subsidised through the Pharmaceutical Benefits Scheme (PBS). NOACs have similar benefits to warfarin in terms of stroke prevention, but a decreased risk of intracranial haemorrhage.[6–8] Therefore, they are considered safer therapy for people with an increased risk of bleeding.

OAC prescribing to patients with AF on discharge is considered best practice in Australia.[9] Yet, despite their benefits, OACs are commonly under-utilised in people with AF. While use of OACs has increased in Australia since the introduction of the NOACs,[10] many studies of utilisation among high-risk individuals continue to report poor uptake.[11,12] Further, medication adherence is key to deriving benefit,[13] but adherence and persistence to OACs is poor; breaks in therapy and discontinuation are common.[11,14–17]

There are little Australian data about use of OACs in AF patients after hospitalisation. Recent studies conducted in Tasmania and rural Western Australia showed that one-third to half of patients admitted to hospital with AF did not receive any OAC therapy.[18,19] However, these studies were conducted in fewer than 3,000 patients in five hospitals and were based on discharge summaries and electronic medical records, rather than population-based dispensing data.

About the data

Data were sourced from the NDLDP, and comprise linked admitted patient, pharmaceutical dispensing and mortality data. Data linkage was undertaken by AIHW.

Data are from 33,806 patients discharged from a Victorian public hospital between July 2011 and December 2013, with a primary or secondary diagnosis of AF (ICD-10-AM code I48.x) who met the inclusion criteria.

For each patient, their most recent admission with an AF diagnosis was identified. Changes in type of care within a hospital (e.g. from acute to sub-acute care), and transfers between hospitals, were treated as continuations of single hospitalisations.

AF was the primary diagnosis in 26.2% of admissions. The majority of patients were aged 75–84 years (40.8%), and 50.2% were male. Nearly all individuals were at high risk of stroke (CHA_2DS_2-VASc score ≥ 2, 95%). In the year before the most recent admission, one-fifth had been hospitalised for AF (20.0%) and one-third (32.8%) had been dispensed an OAC. Direct current cardioversion (DCC) was uncommon; only 5.6% received this procedure during their most recent admission. Within the 1 year follow-up period, 3.8% died within 30 days of discharge, while a further 12.9% died between 31 days and 1 year. 43.5% were readmitted for any reason during the year following discharge. See Table 1.1.

Patient variation in 30-day OAC dispensing was explored by the hospital of discharge. For each hospital a predicted proportion of patients dispensed the relevant medicine within 30 days was estimated using multilevel models, with patients clustered within their hospital of discharge. To predict OAC dispensing estimates, multilevel logistic models adjusted for age (in 5-year increments from 50 years) and sex, with hospital variation quantified using a random-intercept parameter.[20]

Hospital-specific effects in multilevel models are calculated using a 'shrunken residual', which accounts for units with greater uncertainty (e.g. hospitals with smaller size, or higher levels of variation) by 'shrinking' the estimate closer to the mean. Analysis of multilevel models was performed using MLwiN statistical software.

The predicted proportion of patients from each hospital dispensing within 30 days of discharge was then calculated by combining the patient-level effects from the model (reflecting the age and sex distribution of the patient population) with the hospital-level random effect.

See Appendix 1 for further information on the study methodology.

Results

Two-thirds of AF patients did not have an OAC dispensed within 30 days of discharge

Of patients alive 30 days post discharge, 30.4% were dispensed an OAC within 30 days of discharge. Of these patients, 33% had an OAC dispensed on the day of discharge. The most commonly dispensed OAC was warfarin (90.8%), followed by rivaroxaban (6.9%). See Table 1.2.

OAC dispensing within 30 days was highest in people aged 65–84 years, but lowest in those aged under 55 years and those aged 85 years or over, likely due to the increased risk of complications in this age group.[21] The highest rates of dispensing of an OAC within 30 days were observed for people with: a CHA2DS2-VASc score ≥ 2 (31.1%); a primary diagnosis of AF (39.0%); a prior dispensing of an OAC (54.2%); DCC on most recent admission (54.2%); and a prior hospitalisation for stroke (43.3%). See Table 1.3.

At 1 year post-discharge 47.1% of patients alive at 30-days had been dispensed an OAC. Of these patients, 95.3% had their first dispensing within the first 6 months following discharge. See Table 1.4.

There is significant variation in 30-day OAC dispensing by hospital of discharge

Multilevel modelling demonstrated significant variation between hospitals in the proportion of AF patients dispensed an OAC within 30 days ($p < 0.001$), with predicted proportion of discharged patients dispensed an OAC within 30 days ranging from 22% to 40%.

Discussion

Despite evidence-based recommendations to prescribe OACs post-hospital discharge for most patients with AF, two-thirds of patients were not dispensed an OAC within 30 days of discharge, and more than half were not dispensed an OAC in the first year.

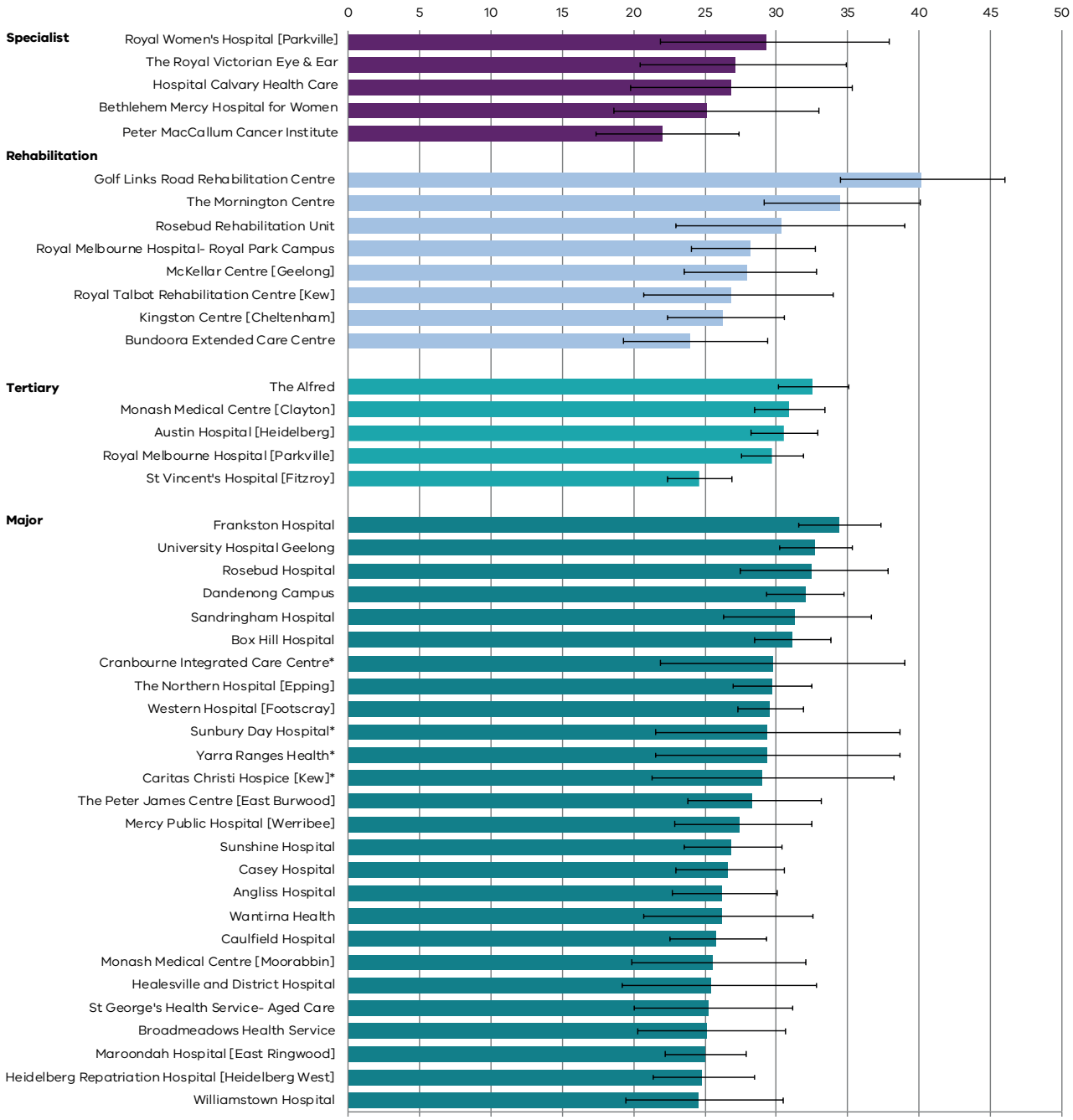
There was significant between-hospital variation in 30-day dispensing rates. Differences in clinical practice and patient casemix are likely contributors to this variation. The highest rate of OAC dispensing was 40%, indicating the potential for improvement even in the best performing hospitals.

Warfarin was the most commonly dispensed OAC during the study period, as NOACs only became widely available in later years. NOACs generally have a better safety profile than warfarin and as a result there has been increasing uptake of NOACs in Australia since late 2013, after the end of our study period.[10] However, while use of OACs has increased in Australia since the introduction of the NOACs,[10] recent studies have demonstrated that underuse in patients hospitalised for AF persists.[18,19]

Achieving a 100% dispensing rate is neither feasible nor desirable. OACs carry an increased risk of haemorrhage and are not recommended in low risk individuals, or in people with contraindications to OAC therapy.[22] However the vast majority (95%) of AF patients in this study were considered high risk of stroke based on their CHA_2DS_2-VASc score, and OAC therapy is recommended in this population.[23]

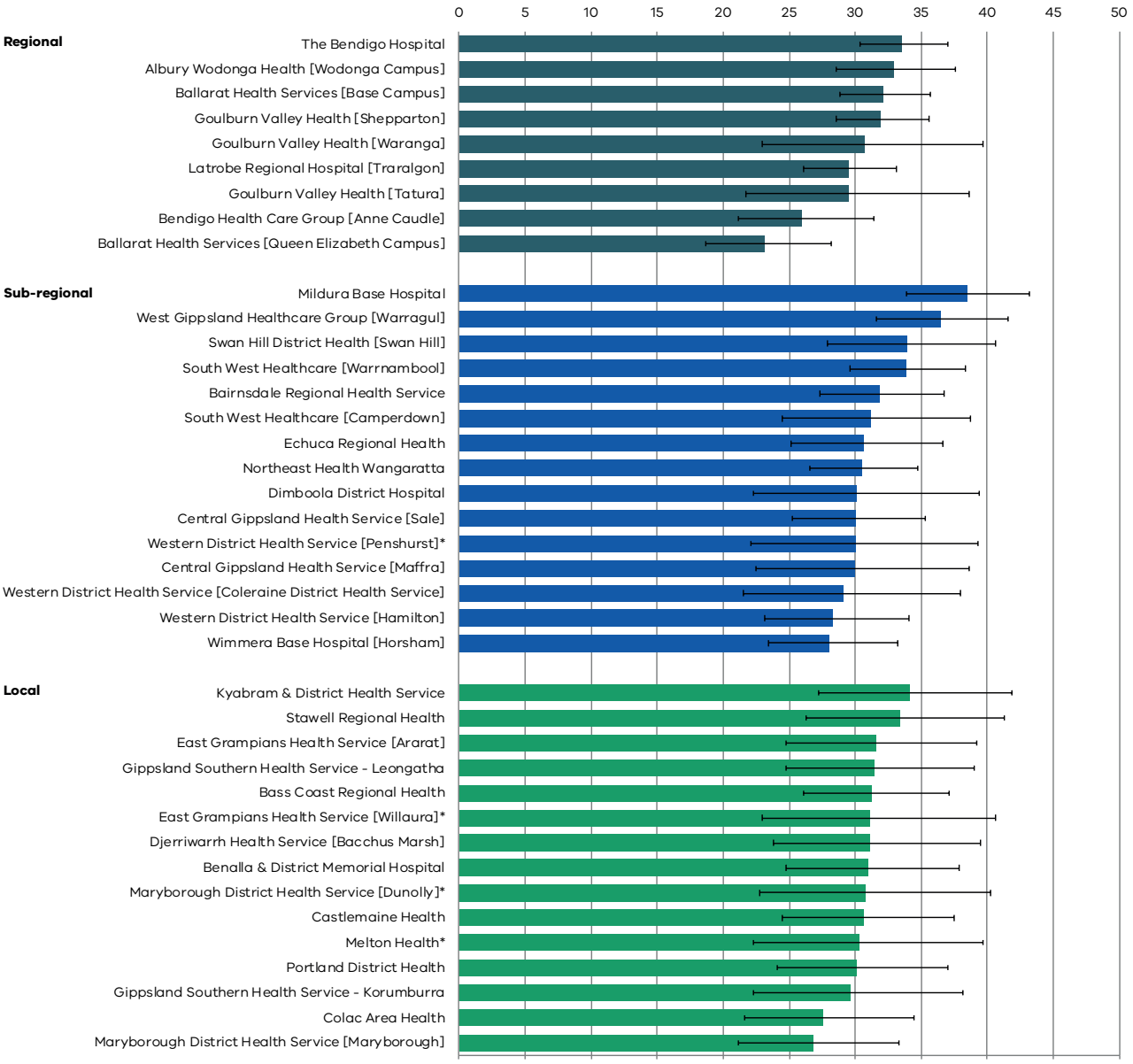
A systematic review of warfarin use in AF estimates that one stroke and one death will be prevented for every 40 and 59 people treated, respectively.[4] Even a modest increase (i.e 10%) on the rate of OAC dispensing reported by this study could prevent a significant number of strokes and ultimately deaths.

Predicted proportion of discharged patients dispensed an OAC within 30 days (%)



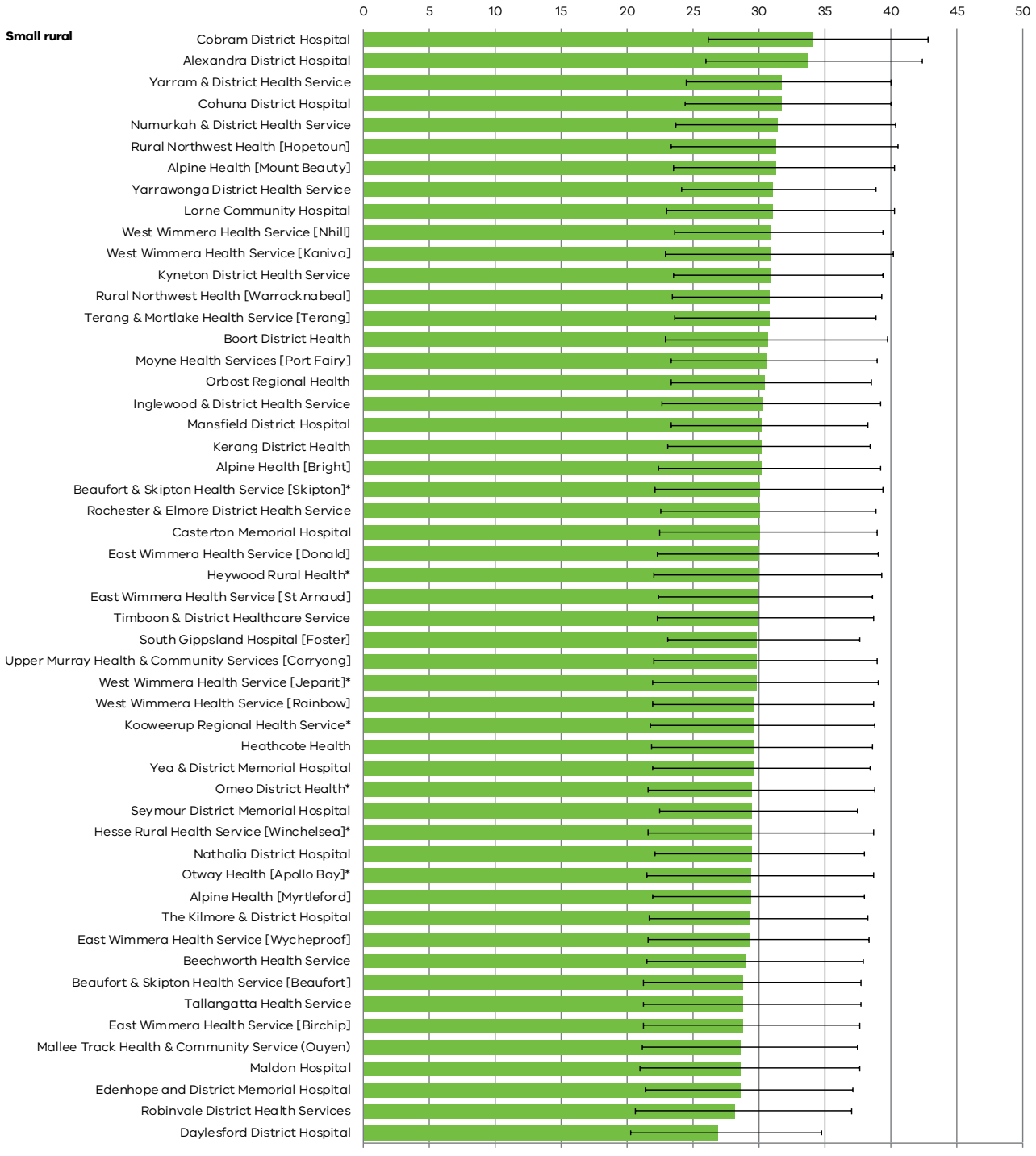
* Indicates fewer than 5 patients discharged from hospital.

Predicted proportion of discharged patients dispensed an OAC within 30 days (%) (continued)



* Indicates fewer than 5 patients discharged from hospital.

Predicted proportion of discharged patients dispensed an OAC within 30 days (%) (continued)



* Indicates fewer than 5 patients discharged from hospital.

Use of dual antiplatelet therapy in acute myocardial infarction

Introduction

The aim of this investigation is to describe rates of adenosine diphosphate (ADP) receptor antagonists dispensing among people hospitalised for an acute myocardial infarction (AMI) from July 2011 to December 2013, using population-level linked data.

An AMI, commonly referred to as a heart attack, is a life-threatening event that occurs when a blood vessel supplying the heart is blocked, damaging the heart muscle and its functions.[24] While risk factors for AMI are well known, including hypertension, diabetes, low physical activity and male gender,[25] rates of AMI have been increasing in Australia,[26] and in 2014–15 there were over 32,000 hospitalisations for AMI among Australian adults.[27]

Best practice pharmacological treatment of patients with AMI includes dual antiplatelet therapy (DAPT) with aspirin and an ADP receptor antagonist, such as clopidogrel, prasugrel or ticagrelor, for up to 12 months.[28] The evidence supporting DAPT is unequivocal.[29,30] Treatment with aspirin and clopidogrel reduces the 1-year incidence of cardiovascular events (including cardiovascular death, stroke, and subsequent myocardial infarction) by 20%.[31] Further reductions have been demonstrated with dual therapy with prasugrel or ticagrelor in place of clopidogrel, particularly among patients who have received a percutaneous coronary intervention (PCI).[30,32,33] The use of ADP receptor antagonists does however carry an increased risk of bleeding that may not be offset by its benefits for some individuals.[28]

Recent Australian hospital-based studies on patients with acute coronary syndrome have found DAPT to be underutilised, with reports of at least 30% of patients not being prescribed DAPT on discharge.[34,35] While prescribing rates are higher among patients strongly indicated for use, such as patients receiving a PCI,[34,35] DAPT is recommended for all patients without contraindications such as excessive risk of bleeding.[30] While these studies were based on large hospital-based registries, there is little information available at the population-level, nor on persistence in the use of DAPT following discharge.

About the data

Data were sourced from the NDLDP, and comprise linked admitted patient, pharmaceutical dispensing and mortality data. Data linkage was undertaken by AIHW.

Data are from 10,639 patients discharged from a Victorian public hospital between July 2011 and December 2013 with a primary diagnosis of AMI (ICD-10-AM code I21.x), who met the inclusion criteria.

For each patient, their most recent admission with an AMI diagnosis was identified. Changes to the type of care within a hospital (e.g. from acute to subacute care), and transfers between hospitals were considered to be part of a single hospitalisation. Patients were followed-up from the last recorded admission in a public hospital.

The majority of patients were aged between 65–84 (62.1%) and male (59.3%). 30.3% of patients had a PCI during their admission, and 11.3% had a hospital diagnosis of major bleeding within the admission or year prior.

Within the follow-up period, 2.7% of patients died within 30 days of discharge and a further 10.5% died between 31 days and 1 year. 57.5% of patients were re-admitted to hospital within one year of discharge. See Table 2.1.

Patient variation in 30-day dispensing was explored by hospital of discharge. For each hospital a predicted proportion of patients dispensed the relevant medicine within 30 days was estimated using multilevel models, with patients clustered within their hospital of discharge. To predict ADP dispensing estimates using multilevel logistic models, results were adjusted for age (in 5-year increments from 50 years) and sex, with hospital variation quantified using a random-intercept parameter.[20]

Hospital-specific effects in multilevel models are calculated using a 'shrunken residual', which accounts for units with greater uncertainty (e.g. hospitals with smaller size, or higher levels of variation) by 'shrinking' the estimate closer to the mean. Analysis of multilevel models was performed using MLwiN statistical software.

The predicted proportion of patients from each hospital dispensing within 30 days of discharge was then calculated by combining the patient-level effects from the model (reflecting the age and sex distribution of the patient population) with the hospital-level random effect.

See Appendix 2 for further information on study methodology.

Results

Almost half of patients did not have an ADP receptor antagonist dispensed within 30 days of discharge

Of patients alive 30 days post discharge, 53.9% were dispensed an ADP receptor antagonist within 30 days of discharge. Dispensing of an ADP receptor antagonist within 30 days was greatest in people aged ≤ 55 years (66.6%) and decreased with increasing age. The highest rates of dispensing of an ADP receptor antagonist within 30 days were observed for people who had a PCI during their most recent AMI admission (91.4%). See Table 2.2.

The most common ADP receptor antagonist first dispensed after discharge was clopidogrel and clopidogrel/aspirin combination (78.7%). Ticagrelor was dispensed in 12.9% cases, while 8.5% of dispensings were for prasugrel. See Table 2.3.

The majority of patients dispensed an ADP receptor antagonist in the year following discharge received it within the first 30 days. A large proportion of patients had a dispensing on the day of discharge (31.2%). Only 6.2% of patients were first dispensed an ADP receptor antagonist more than 30 days after discharge. See Table 2.4.

There is significant variation in 30-day dispensing of ADP receptor antagonists by hospital of discharge

Multilevel modelling demonstrated significant variation between hospitals in the proportion of AMI patients dispensed DAPT within 30 days ($p < 0.001$), with predicted proportion of discharged patients dispensed DAPT within 30 days ranging from 22% to 74%. Between-hospital variation in rates of ADP receptor antagonist dispensing was found within all major hospital peer groups. While there were between-hospital variations within other peer groups of smaller and specialised facilities, the smaller number of patients within these hospitals limits the extent to which robust comparisons can be made.

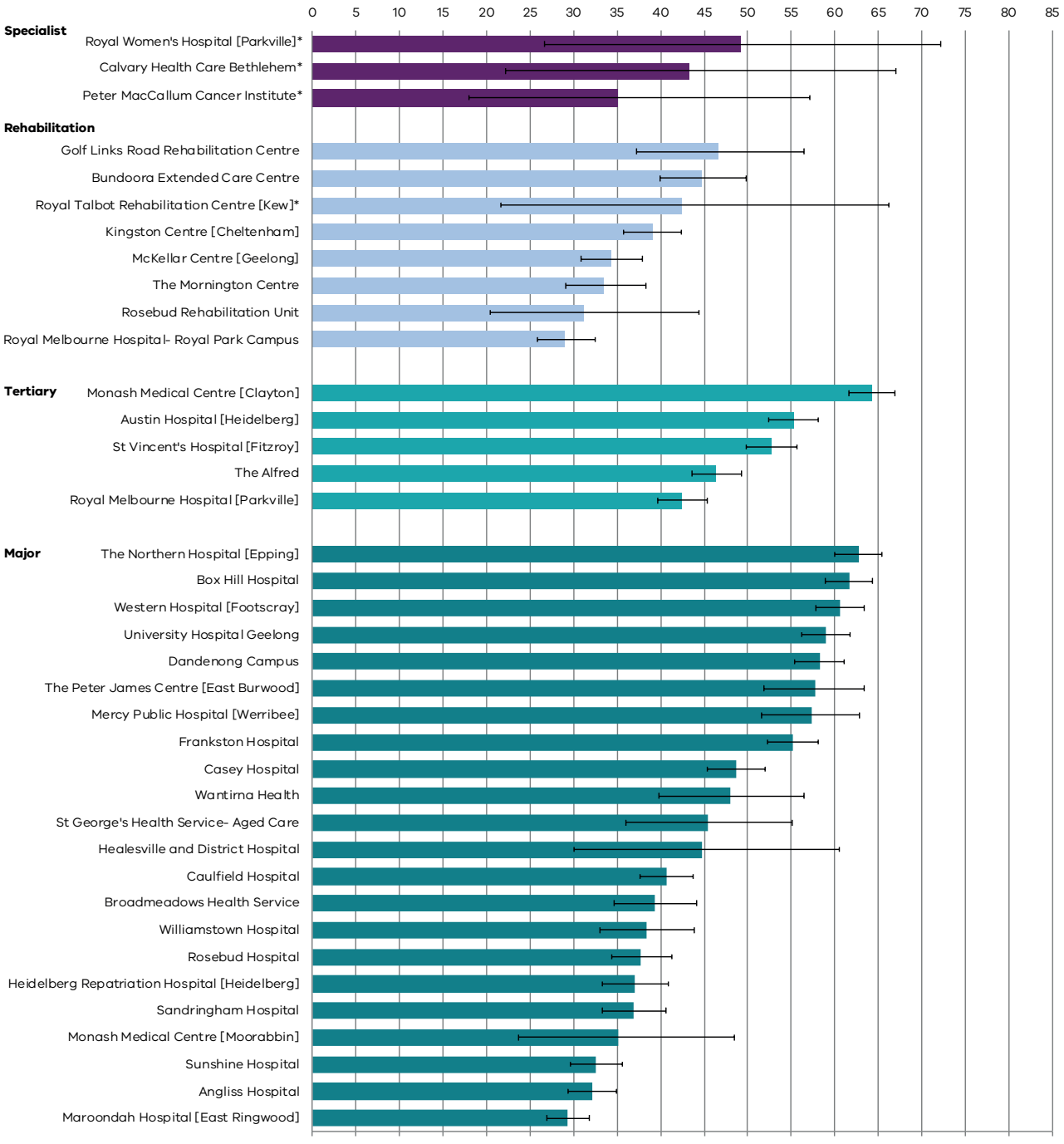
Discussion

Dispensing of ADP receptor antagonists was low among people discharged from hospital with AMI. Almost half of patients (46.1%) were not dispensed an ADP receptor antagonist within 30 days of discharge. The vast majority (90%) of patients dispensed an ADP receptor antagonist in the year following discharge received it within the first 30 days, suggesting that the first 30 days is a window of opportunity for optimal prescribing.

There was significant between-hospital variation in 30-day dispensing rates. There are many potential reasons for this variation: some may relate to differences in the clinical casemix of patients; some may relate to the facility's capacity to manage complex cardiac care, such as presence of a catheterisation laboratory to undertake a PCI; and some of the variation may relate to differences in clinical practice of prescribing medicines.

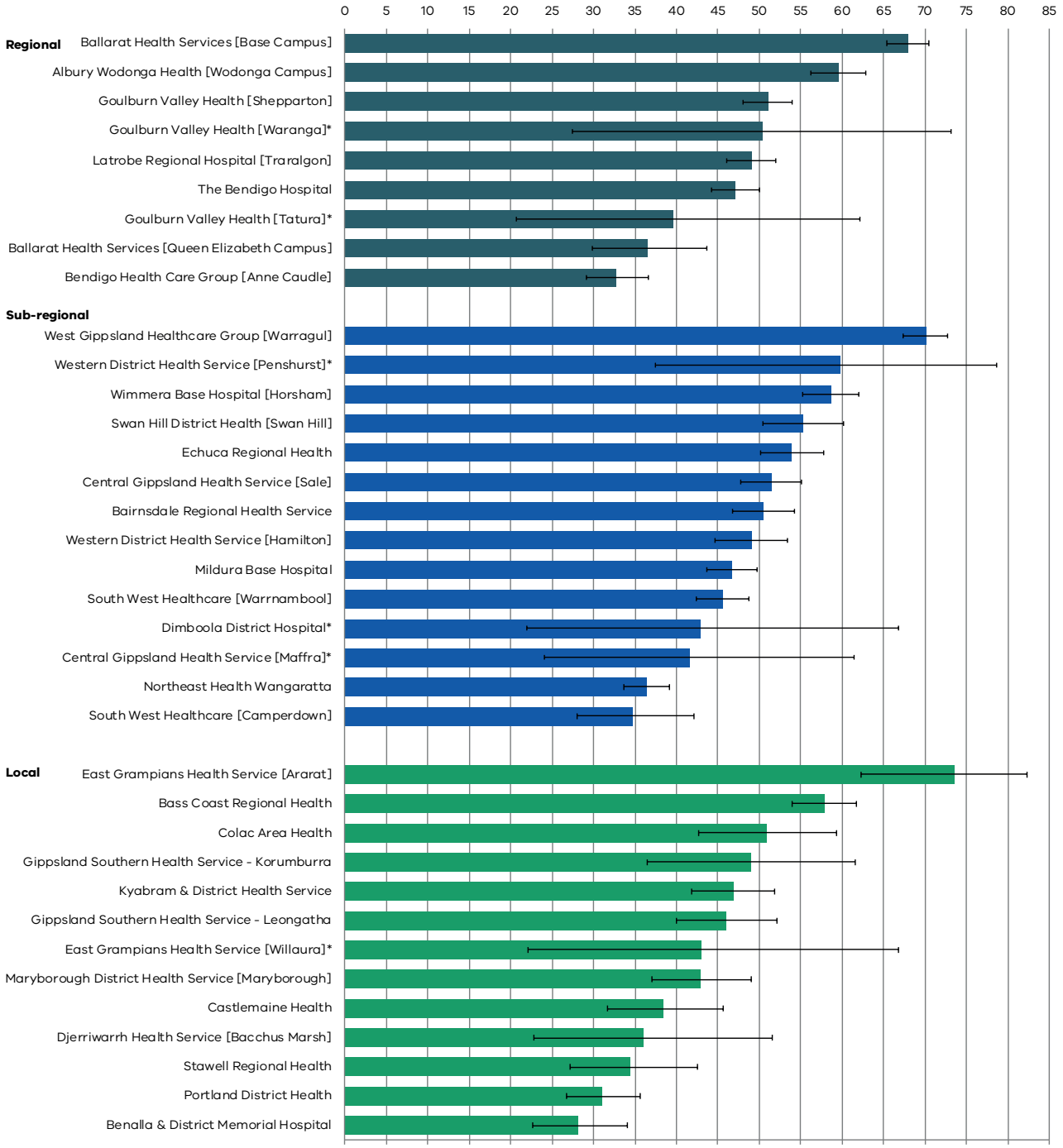
Due to contraindications and the risk of major bleeding from DAPT, it is not realistic to expect hospitals to have all patients with discharge diagnosis of AMI to be prescribed DAPT. However, the wealth of data regarding clinical effectiveness of DAPT in patients with acute coronary syndrome (ACS) suggests increased prescribing would have a net benefit by decreasing the rates of recurrent AMI and stroke.[36]

Predicted proportion of discharged patients dispensed an ADP receptor antagonist within 30 days



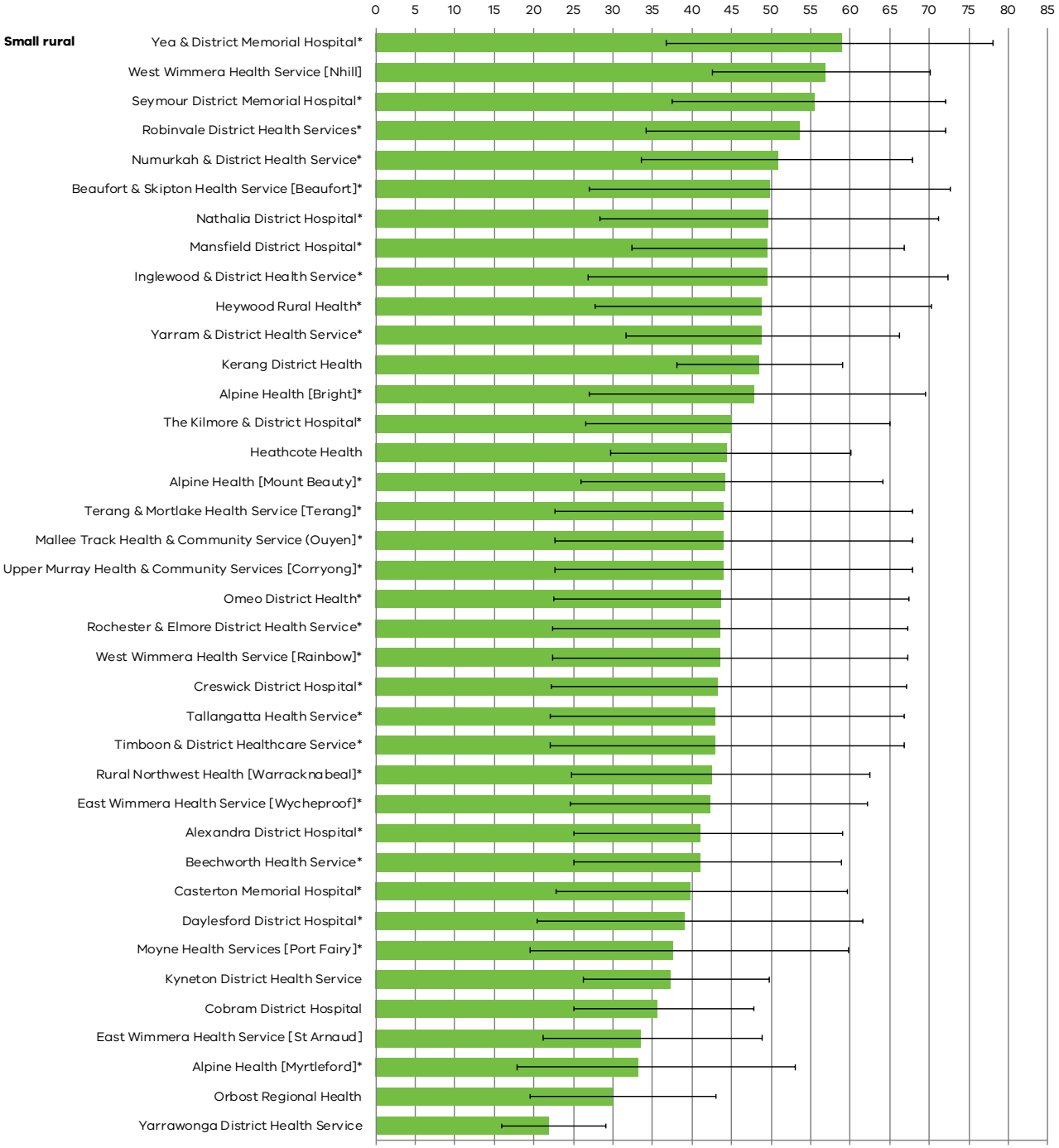
* Indicates fewer than 5 patients discharged from hospital.

Predicted proportion of discharged patients dispensed an ADP receptor antagonist within 30 days (continued)



* Indicates fewer than 5 patients discharged from hospital.

Predicted proportion of discharged patients dispensed an ADP receptor antagonist within 30 days (continued)



* Indicates fewer than 5 patients discharged from hospital.

Implications for practice

Variation in care is a common phenomenon across most healthcare delivery. In these studies there were significant differences in prescribing patterns in hospitals who cared for AF and AMI patients.

Focusing on variation in care, and strategies to reduce it, can help ensure everyone is receiving high quality care.

Ensuring all patients with AF or AMI are routinely assessed for appropriate pharmacotherapy at discharge is one way to reduce unwarranted variation in practice and increase appropriate use of guideline-based therapies.

Increased appropriate use of anticoagulation in patients with AF will reduce incidents of stroke and ultimately death. Similarly, increasing the appropriate use of antiplatelet agents in patients with AMI will reduce future heart attacks and death.

This project demonstrated that data linkage can enable evaluation of patient care pathways across both hospital and community-based services. Linked data provide essential information to identify evidence-practice gaps and investigate variation in care in Australia. The findings can be used to drive quality improvement in cardiac care across the Victorian health system.

Further work is required to determine the factors influencing the lower than expected dispensing rates and the observed variation by hospital of discharge. Further development of the linked database would only add value to the utility of the project

Tables

Table 1.1: Demographic and clinical characteristics of patients discharged with a primary or secondary diagnosis of atrial fibrillation (AF)

	Patients	% N
All patients (N)	**33,806**	**100.0**
Demographics		
Age at discharge		
18–55 years	1,051	3.1
55–64 years	2,362	7.0
65–74 years	8,794	26.0
75–84 years	13,794	40.8
≥ 85 years	7,805	23.1
Sex		
Female	16,832	49.8
Male	16,974	50.2
Date of discharge of most recent admission		
Jul–Dec 2011	6,022	17.8
Jan–Jun 2012	6,027	17.8
Jul–Dec 2012	6,735	19.9
Jan–Jun 2013	6,630	19.6
Jul–Dec 2013	8,392	24.8
Clinical characteristics		
Diagnosis		
Primary	8,859	26.2
Secondary	24,947	73.8
CHA_2DS_2-VASc score		
0 (low risk of stroke)	455	1.3
1 (moderate risk of stroke)	1,247	3.7
≥ 2 (high risk of stroke)	32,104	95.0

Table 1.1: Demographic and clinical characteristics of patients discharged with a primary or secondary diagnosis of atrial fibrillation (AF) (continued)

	Patients	% N
Direct current cardioversion on most recent admission		
Yes	1,896	5.6
No	31,910	94.4
Prior AF admission within 1 year		
Yes	6,774	20.0
No	27,032	80.0
Prior OAC dispensing within 1 year		
Yes	11,092	32.8
No	22,714	67.2
Prior admission for stroke within 1 year		
Yes	2,119	6.3
No	31,687	93.7
Patient follow-up		
Died (all cause)		
Within 30 days of discharge	1,295	3.8
Within 1 year of discharge	5,638	16.7
Readmission (all cause)		
Within 30 days of discharge	5,502	16.3
Within 1 year of discharge	14,699	43.5

Table 1.2: First OAC dispensed among AF patients who were alive and dispensed an OAC within 30 days of discharge

	Patients	% N
Patients with an OAC dispensing within 30 days (N)	**9,879**	**100.0**
First OAC dispensed		
Warfarin	8,968	90.8
Apixaban	62	0.6
Dabigatran	166	1.7
Rivaroxaban	680	6.9
Multiple	3	0.0

Table 1.3: Proportion dispensed an OAC within 30 days of discharge among AF patients alive at 30 days post-discharge, by patient demographic, clinical characteristics

	Patients with a dispensing within 30 days	% of all patients in each stratum
All patients	**9,879**	**30.4**
Demographics		
Age at discharge		
18–55 years	218	20.9
55–64 years	686	29.6
65–74 years	2,930	34.0
75–84 years	4,434	33.3
≥ 85 years	1,611	22.4
Sex		
Male	4,989	30.8
Female	4,890	30.0
Date of discharge		
Jul–Dec 2011	1,543	26.8
Jan–Jun 2012	1,588	27.4
Jul–Dec 2012	1,860	28.6
Jan–Jun 2013	1,830	28.8
Jul–Dec 2013	3,058	37.6
Clinical characteristics		
Diagnosis		
Primary	3397	39.0
Secondary	6482	27.2
CHA_2DS_2-VASc score		
0 (low risk of stroke)	59	13.0
1 (moderate risk of stroke)	229	18.6
≥ 2 (high risk of stroke)	9,591	31.1

Table 1.3: Proportion dispensed an OAC within 30 days of discharge among AF patients alive at 30 days post-discharge, by patient demographic, clinical characteristics (continued)

	Patients with a dispensing within 30 days	% of all patients in each stratum
Direct current cardioversion on most recent admission		
Yes	800	54.2
No	9,079	29.3
Prior AF admission within 1 year		
Yes	2,382	36.9
No	7,487	28.8
Prior OAC dispensing within 1 year		
Yes	5,815	54.2
No	4,064	18.7
Prior admission for stroke within 1 year		
Yes	874	43.3
No	9,005	29.5

Table 1.4: Time to first OAC dispensing within 1 year of discharge among AF patients alive at 30 days post-discharge

	Patients	% N
All patients (N)	**32,511**	**100.0**
OAC dispensing within 1 year		
Yes	15,322	47.1
No	17,189	52.9
Time to first dispensing		
Day of discharge	3,264	10.0
1–7 days	2,283	7.0
8–30 days	4,332	13.3
31–183 days	4,720	14.5
84–365 days	723	2.2
None within 1 year	17,189	52.9

Table 2.1: Demographic and clinical characteristics of patients with a primary diagnosis of acute myocardial infarction (AMI)

	Patients	% N
All patients (N)	**10,639**	**100.0**
Demographics		
Age at discharge		
18–55 years	857	8.1
55–64 years	1,268	11.9
65–74 years	3,056	28.7
75–84 years	3,553	33.4
≥ 85 years	1,905	17.9
Sex		
Female	4,329	40.7
Male	6,310	59.3
Date of discharge		
Jul–Dec 2011	2,267	21.3
Jan–Jun 2012	2,119	19.9
Jul–Dec 2012	2,209	20.8
Jan–Jun 2013	1,931	18.2
Jul–Dec 2013	2,113	19.9
Clinical characteristics		
Intervention on AMI admission		
PCI	3,222	30.3
CABG	784	7.4
Neither	6,633	62.3
Major bleeding diagnosis		
On admission/within 1 year prior	1,197	11.3
No recorded diagnoses	9,442	88.7

Table 2.1: Demographic and clinical characteristics of patients with a primary diagnosis of acute myocardial infarction (AMI) (continued)

	Patients	% N
Prior admission for AMI		
Admitted within 1 year prior	1,279	12.0
None	9,360	88.0
Prior ADP receptor antagonist		
Dispensed within 1 year prior	1,670	15.7
None	8,969	84.3
Patient follow-up		
Died (all cause)		
Within 30 days of discharge	291	2.7
Within 1 year of discharge	1,407	13.2
Readmission (all cause)		
Within 30 days of discharge	2,156	20.3
Within 1 year of discharge	6,121	57.5

Table 2.2: Patients dispensed an ADP receptor antagonist within 30 days of discharge for AMI, as a proportion of all patients alive 30 days from discharge within each stratum, by patient demographic and clinical characteristics

	Patients with a dispensing within 30 days	% of all patients in stratum
Patients who were dispensed an ADP receptor antagonist within, and were alive at, 30 days following discharge	**5,579**	**53.9**
Demographics		
By age		
18–55 years	569	66.6
55–64 years	798	63.4
65–74 years	1,813	60.1
75–84 years	1,738	50.4
≥ 85 years	661	37.4
By sex		
Female	2,010	48.0
Male	3,569	57.9
By date most recent AMI admission		
Jul–Dec 2011	1,076	48.8
Jan–Jun 2012	1,032	50.2
Jul–Dec 2012	1,196	55.3
Jan–Jun 2013	1,070	57.1
Jul–Dec 2013	1,205	58.7
Clinical characteristics		
By intervention on AMI admission		
PCI	2,936	91.4
CABG	103	13.2
None	2,540	40.0
By major bleeding diagnosis		
On admission/within 1 year prior	495	43.2
No recorded diagnoses	5,084	55.3

Table 2.2: Patients dispensed an ADP receptor antagonist within 30 days of discharge for AMI, as a proportion of all patients alive 30 days from discharge within each stratum, by patient demographic and clinical characteristics (continued)

	Patients with a dispensing within 30 days	% of all patients in stratum
By prior admission for AMI		
Admitted within 1 year prior	627	51.3
None	4,952	54.3
By prior ADP receptor antagonist		
Dispensed within 1 year prior	1,211	74.8
None	4,368	50.0

Table 2.3: First ADP receptor antagonist dispensed among patients who were alive and dispensed an ADP receptor antagonist within 30 days of discharge

	Patients	% N
Patients dispensing within 30 days (N)	**5,579**	**100.0**
First ADP receptor antagonist dispensed		
Clopidogrel	3,345	60.0
Clopidogrel & aspirin combination	1,041	18.7
Prasugrel	473	8.5
Ticagrelor	720	12.9

Table 2.4: Time to first dispensing of ADP receptor antagonist within 1 year of discharge

	Patients	% N
All patients (N)	**10,639**	**100.0**
Time to first dispensing		
On day of discharge	3,318	31.2
1–7 days	763	7.2
8–30 days	1,556	14.6
31–182 days	561	5.3
183–365 days	95	0.9
None	4,346	40.8

Appendix 1: Methodology – Use of oral anticoagulants in atrial fibrillation

Data sources

This analysis used linked admitted patient, pharmaceutical dispensing and mortality data from the NDLDP. Data linkage of the NDLDP was undertaken by the AIHW.[37]

Public hospital admitted patient episode data were drawn from the National Hospital Morbidity Database (NHMD) and contain all records for admissions to public hospitals in Victoria between July 2010 and June 2015.

Mortality data were from the National Death Index (NDI) data, containing records for all deaths registered between July 2010 and December 2015 where the individual resided in Victoria at the time of death, or received treatment in Victoria during the study period.

Pharmaceutical data were drawn from the Pharmaceutical Benefits Scheme (PBS) data and contain records for all PBS services processed between July 2010 and June 2015. This extract does not capture information on PBS-listed medicines where the government did not contribute towards the cost; that is, medicines that cost less than the patient co-payment. The co-payment for general beneficiaries was $34.20 in 2011 and $36.90 in 2014 and the co-payment for concessional beneficiaries was $5.60 in 2011 and $6.00 in 2014.[38]

Study population

All patients discharged from a Victorian public hospital between July 2011 and December 2013, with a primary or secondary diagnosis of AF (ICD-10-AM code I48.x) were included. For each patient, their most recent admission with an AF diagnosis was identified. Changes in type of care within a hospital (e.g. from acute to sub-acute care), and transfers between hospitals, were treated as continuations of single hospitalisations.

Patients who met the following criteria were excluded:

- younger than 18 years on the day of discharge
- died in-hospital
- not a resident of Victoria during the study period
- inconsistencies in the data indicating potential linkage errors (e.g. hospital admission after date of death)
- hospital admission funded by the Department of Veterans' Affairs (DVA), as medicine dispensings are not all captured in the PBS data for this population.

As the cost of some OACs was less than the general beneficiary co-payment during the study period, but greater than the concessional beneficiary co-payment, only those who were concessional beneficiaries during the 365 days prior to their index admission and 365 days post discharge were included to ensure complete capture of OAC dispensing for the study population during the study period.

Concessional beneficiary status was ascertained based on each patient's dispensings during the study period. Individuals with ≥1 dispensing with a non-concessional entitlement status were excluded. Those with no PBS dispensings during the study period were excluded because concessional status could not be determined.

Medicines of interest

Medicines of interest included warfarin, apixaban, dabigatran and rivaroxaban. Warfarin is a vitamin K antagonist, while the latter three medicines are non-vitamin K antagonists (NOACs). Warfarin has no restriction for PBS prescribing. Apixaban, dabigatran and rivaroxaban are authority (restricted) items, subsidised on the PBS for prevention of stroke in patients with AF in September 2013, September 2013, and December 2012, respectively.

Outcomes of interest

The outcomes of interest were the following:

- Demographic and clinical characteristics of people discharged from a public hospital with a primary or secondary diagnosis of AF.
- Dispensing of an OAC within 30 days of discharge from a public hospital with a primary or secondary diagnosis of AF.
- Variation in dispensing of an OAC within 30 days of discharge by public hospital.
- Persistence on OAC therapy among people dispensed an OAC within 30 days of discharge.

Statistical analysis

Clinical characteristics of admitted patients during the most recent AF admission (age, sex, direct current cardioversion (DCC)), in the year prior to the most recent admission (admission for AF, dispensing of an OAC, admission for stroke, CHA_2DS_2-VASc), and in the year after discharge (all-cause death and re-admission) were identified for all patients. DCC is a procedure used to restore normal heart rhythm. The CHA_2DS_2-VASc score approximates each individual's risk of stroke, and is based on the patient's sex, age, and history of heart failure, hypertension, diabetes, stroke, and vascular disease. A score of 0 is low risk and OACs are not recommended, while a score of 1 is moderate risk and OACs should be considered. Patients with a score ≥ 2 are at a high risk of stroke and should be taking OACs.[39]

Dispensing of an OAC after discharge, within 30 days and 1 year were the prescribing windows considered. 30-day variation in dispensing of an OAC by hospital of discharge and peer group was calculating assuming all hospitals had the same age and sex distribution. Persistence (i.e. continued use of OACs without a break in therapy) at 1 year, and predictors of non-persistence (i.e. discontinuation) were also outcome measures of interest. Non-persistence was defined as a gap in OAC therapy of 60 days or more. People who died within 1 year of initiation were only considered non-persistent if they had a gap of 60 days or more prior to death.

Appendix 2: Methdology – Use of dual antiplatelet therapy in acute myocardial infarction

Data sources

This analysis used linked admitted patient, pharmaceutical dispensing and mortality data from the NDLDP. Data linkage of the NDLDP was undertaken by the AIHW.[37]

Public hospital admitted patient episode data were drawn from the National Hospital Morbidity Database (NHMD) and contain all records for admissions to public hospitals in Victoria between July 2010 and June 2015.

Mortality data were from the National Death Index (NDI) data, containing records for all deaths registered between July 2010 and December 2015 where the individual resided in NSW or Victoria at the time of death, had received treatment in a Victorian emergency department or public hospital, and was dispensed a PBS medicine in Victoria.

Pharmaceutical data were drawn from the Pharmaceutical Benefits Scheme (PBS) data, and contain records for all PBS services processed between July 2010 and June 2015. This extract does not capture information on PBS-listed medicines where the government did not contribute towards the cost; that is, medicines that cost less than the patient co-payment. The co-payment for general beneficiaries was $34.20 in 2011 and $36.90 in 2014 and the co-payment for concessional beneficiaries was $5.60 in 2011 and $6.00 in 2014.[38]

Study population

All patients discharged from a Victorian public hospital between July 2011 and December 2013, with a primary diagnosis of AMI (ICD-10-AM code I21.x), who were alive and 18 years or older at the time of discharge were included. For each patient, their most recent admission with an AMI diagnosis was identified. Changes to the type of care within a hospital (e.g. from acute to subacute care) and transfers between hospitals were considered to be part of a single hospitalisation. Patients were followed-up from the last recorded admission in a public hospital.

Patients were excluded if they were not a resident of Victoria during the study period, or if they had inconsistent data indicating potential linkage errors (e.g. hospital admission after date of death). Individuals with Department of Veteran's Affairs (DVA) funding status on their admission were also excluded, as their medicine dispensings are not captured by the PBS.

The study population was restricted to individuals who were concessional beneficiaries during the 365 days prior to admission and 365 days post-discharge because the cost of some ADP receptor antagonists was less than the general beneficiary co-payment during the study period, but greater than the concessional beneficiary co-payment. This restriction was performed by further excluding patients with either no PBS claims (as most dispensings by concessional beneficiaries would be captured in the PBS data), or any claim as a non-concessional (i.e. general) beneficiary.

Medicines of interest

The ADP receptor antagonists of interest were any one of clopidogrel (including combination therapy with aspirin), prasugrel or ticagrelor. While DAPT with aspirin and an ADP receptor antagonist is best-practice treatment for patients with AMI, the availability of aspirin as an over-the-counter medicine means it is under-ascertained in the PBS data. Given monotherapy with clopidogrel is only recommended if aspirin is contraindicated or not tolerated,[28] and recent Australian findings showing most patients with acute coronary syndrome (ACS) taking ADP receptor antagonists are doing so as dual therapy with aspirin,[35] we have assumed that dispensing of ADP receptor antagonists within this population would be as dual therapy with aspirin.

We investigated dispensing of PBS-subsidised ADP receptor antagonists. The PBS subsidises the cost of prescribed PBS-listed medicines within community pharmacies and private hospitals, as well as for inpatients in public hospitals upon discharge as part of the Public Hospital Pharmaceutical reforms.[40,41] These reforms allow public hospitals to provide up to 30 days of medicines to patients on discharge from hospital, which are funded through the PBS and so captured in the data. Conversely, hospitals not participating in the reforms provide patients with several days (e.g. 4–7 days) of therapy, which are not funded through the PBS and so not captured in the data. For this reason, medicines dispensed in the period following discharge from hospital were captured rather than specifically at the time of discharge.

Outcomes of interest

Outcomes of interest were the following:

- Demographic and clinical characteristics of people discharged from a public hospital with a primary diagnosis of AMI.
- Dispensing of an ADP receptor antagonist within 30 days of discharge from a public hospital with a primary diagnosis of AMI.
- Variation in dispensing of an ADP receptor antagonist within 30 days of discharge, by the hospital of discharge.
- Persistence on ADP receptor antagonist therapy to 1 year among people dispensed an ADP receptor antagonist within 30 days of discharge.

Statistical analysis

Clinical characteristics of admitted patients during their most recent admission for AMI (age, sex, date of discharge, having either a PCI [stent or coronary angioplasty] or coronary artery bypass graft [CABG]), in the year prior to the most recent admission (admission for AMI, dispensing of an ADP receptor antagonist), either during admission or in the year prior (major bleeding diagnosis), and in the year after discharge (all-cause death and re-admission) were included.

Dispensing of an ADP receptor antagonist after discharge, within 30 days and 1 year was determined. 30-day variation in dispensing of an ADP receptor antagonist by hospital of discharge and peer group was calculated assuming all hospitals had the same age and sex distribution. Persistence (i.e. continued use of ADP receptor antagonists without a break in therapy) at 1 year, and predictors of non-persistence (i.e. discontinuation) was also measured. Non-persistence was defined as a gap in ADP receptor antagonist therapy of 60 days or more. People who died within 1 year of initiation were only considered non-persistent if they had a gap of 60 days or more prior to death.

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