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Anticoagulation and antiplatelet strategies used in Sweden in patients with myocardial infarction and concomitant atrial fibrillation: nationwide cohort study

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ABSTRACT

Background Optimal antithrombotic therapy and its duration, whether triple therapy with dual antiplatelets plus oral anticoagulant (OAC), or dual antithrombotic therapy with an antiplatelet plus OAC, is uncertain for patients with myocardial infarction (MI) and atrial fibrillation (AF).

Methods Patients registered in SWEDEHEART (Swedish Web-system for enhancement and development of evidence-based care in heart disease evaluated according to recommended therapies) for their first MI between 2011 and 2021 with a history or new-onset AF were included (n=26 574). Linkage between SWEDEHEART and Swedish administrative health databases was performed, and pseudonymised data analysed.

Results Over time, OAC use at discharge after MI tripled from 27% in 2011 to 77% in 2021, with direct OACs (DOACs) largely replacing warfarin, predominantly in combination with a single antiplatelet. The strongest factors for initiating OAC therapy were the performance of coronary angiography (OR 1.53 (1.40–1.68)), and percutaneous coronary intervention (OR 1.49 (1.39–1.61)). However, the year of the MI was the most predictive variable associated with OAC initiation, with an OR of 9.31 (7.92–10.95) in 2021 compared with 2011. The clinical factors associated with lower likelihood of OAC initiation were dementia, liver disease, cancer and ST-elevation MI (STEMI) versus non-STEMI.

Conclusions Use of OAC has increased over the years in patients with MI and concurrent AF, primarily driven by the increased adoption of DOACs. Additionally, there has been a shift in antithrombotic combinations, with most patients in recent years receiving DOAC in combination with a single antiplatelet, reflecting the nationwide implementation of recent evidence and guidelines. However, significant variation in antithrombotic therapy strategies remains.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Dual antithrombotic therapy with a single antiplatelet agent plus direct oral anticoagulant (DOAC) reduces bleeding risk compared with triple therapy in patients with myocardial infarction (MI) and atrial fibrillation (AF). Clinical practice guidelines have shifted toward shorter durations of triple therapy, recommending early transition to dual antithrombotic therapy in patients with MI and AF. Despite updated clinical practice guidelines, real-world prescribing patterns remain variable.

WHAT THIS STUDY ADDS

⇒ In Sweden from 2011 to 2021, the use of OACs, particularly DOACs, steadily increased, predominantly as part of dual or triple antithrombotic therapy in patients with MI and concomitant AF. A significant proportion of patients with high CHA_2DS_2-VASc (congestive heart failure, hypertension, age, diabetes, stroke, vascular disease, sex) scores were still discharged without OACs, and inadequate low-dose DOAC prescriptions remained common, highlighting ongoing gaps in optimal care.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This large, registry-based study demonstrates a clear national shift in antithrombotic strategies over time, driven by evolving evidence, but also reveals persistent challenges in implementing clinical practice guidelines.

INTRODUCTION

The optimal antithrombotic treatment strategy for patients with myocardial infarction (MI) and concomitant atrial fibrillation (AF) remains uncertain. Current clinical practice guidelines from the European Society of Cardiology, American Heart Association and American College of Cardiology recommend triple therapy, with dual antiplatelet therapy (DAPT) including aspirin and clopidogrel, plus an oral anticoagulant (OAC), for a short period after a MI and/or percutaneous coronary intervention (PCI) in patients with AF at increased risk for ischaemic stroke.[1–3] In recent years, clinical

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trials with direct OACs (DOACs) have consistently shown that dual antithrombotic therapy with a single antiplatelet therapy (SAPT) plus an OAC leads to considerably lower risk of bleeding than triple therapy.[4–8] This has been demonstrated without any evident increase in the risk of thromboembolic complications such as MI or stent thrombosis, although none of the trials were designed nor large enough to statistically answer this question.[4–8] As a result of these trials, recent knowledge has begun to influence changes not only in international clinical practice guidelines but also in real-life clinical practice.[2 3 9]

In this retrospective observational registry study of prospectively collected data from the Swedish national quality registry SWEDEHEART (Swedish Web-system for enhancement and development of evidence-based care in heart disease evaluated according to recommended therapies), we aimed to descriptively analyse how patients with AF are managed during their first year after an episode of MI with or without PCI. We also sought to investigate predictors underlying treatment decisions and how prescription patterns have evolved over the years in relation to new knowledge and updated guidelines.

METHODS

Study design and participants

This retrospective observational registry study is based on data from national quality registries and mandatory patient registries in Sweden between 2 August 2011 and 31 December 2021. These dates reflect the approval date for the first DOAC for AF in Sweden according to the Swedish Medical Products Agency, and the years of available data. The index date is the date of discharge after an acute MI. All patients registered in SWEDEHEART for their first MI with or without PCI during this period, who had an indication for OAC, either with a history of previous AF or new-onset AF during the hospital visit and were aged ≥18 years were included in this study. Exclusion criteria included: (1) patients with valvular AF (defined as patients with prosthetic mechanical heart valves implanted before discharge or with a diagnosis of mitral stenosis before discharge), identified using International Classification of Diseases, 10th Revision (ICD-10) codes recorded before the index date in the National Patient Registry; (2) severe renal insufficiency (calculated creatinine clearance <15 mL/min), based on creatinine levels recorded in SWEDEHEART (patients with missing creatinine data were excluded); (3) patients with a history of intracranial bleeding before discharge, identified using ICD-10 codes recorded before the index date in the National Patient Registry; (4) patients with major bleeding events during the index hospitalisation; (5) patients who had undergone, or were planned for coronary artery bypass grafting for their index MI event; (6) death during the in-hospital course; (7) additional registrations in SWEDEHEART during the study period (to avoid inclusion of the same patient multiple times). As this is a descriptive study, detailed sample size calculations are not applicable. Collected variables and associated definitions are listed in the online supplemental tables 1 and 2.

Data sources

The study used data from the national quality register for acute MI care and PCI in Sweden (SWEDEHEART: RIKS-HIA (Register of Information and Knowledge about Swedish Heart Intensive Care Admissions) and SCAAR (Swedish Coronary Angiography and Angioplasty Registry)).[10] Data from SWEDEHEART was linked with Swedish administrative health databases using the unique personal identification number available to all Swedish citizens. For this study, additional data on comorbidities and outcomes beyond those available in SWEDEHEART were obtained from the National Patient Registry, a mandatory nationwide registry that includes discharge diagnoses for all patients admitted to Swedish hospitals since 1987.[11] Additionally, mortality data was obtained from the National Cause of Death Registry, a mandatory nationwide registry that has collected vital status information on all Swedish citizens since 1961. Previous studies have shown that these registries have high validity for mortality and several diagnoses, including MI, stroke and major bleeding.[11 12] The National Dispensed Drug Registry was used to capture data on all drug dispenses in Sweden, with available data since 2005.[13]

Patient and public involvement in the study

Patient organisations and/or the public were not involved in the design, conduct, reporting or dissemination plans of this retrospective study.

Consent

All patients included in SWEDEHEART were informed about their participation in the register and were given the option to opt out.

Data management

The linkage of registers was performed by the Swedish National Board of Health and Welfare. All data were completely pseudonymised before being provided to the investigators. All data management and statistical analyses were performed in collaboration with data managers and statisticians at Uppsala Clinical Research Center, Uppsala, Sweden, using R statistics.

Statistical analyses

Patient characteristics, in-hospital treatment (including coronary angiography and PCI), CHA_2DS_2-VASc (congestive heart failure, hypertension, age, diabetes, stroke, vascular disease, sex) score and medications at discharge and over time are presented as medians with 25th–75th percentiles for continuous variables, and as frequencies with percentages for categorical variables. Statistical differences between groups are not presented in the baseline table, as per the recommendations from the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement for observational studies.[14]

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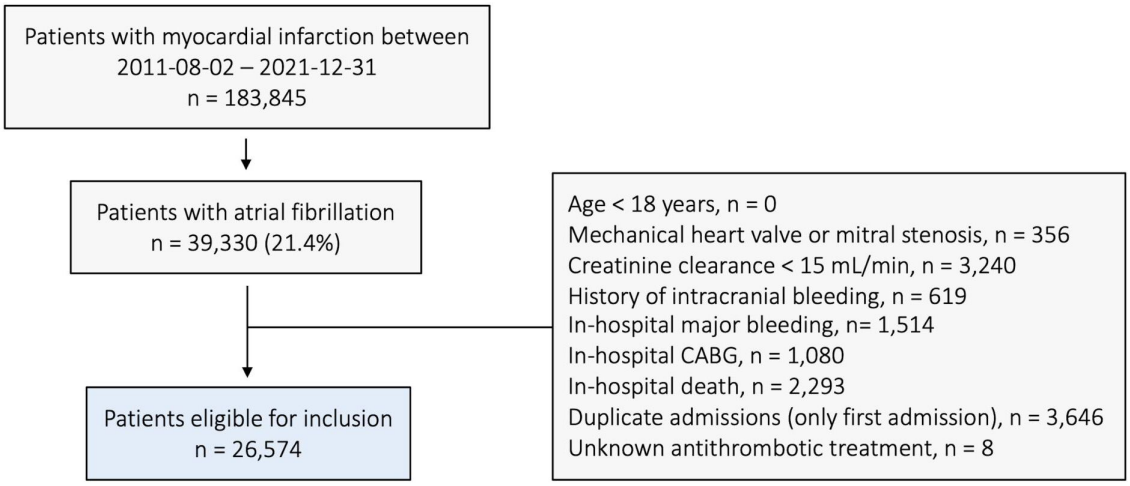

Figure 1 CONSORT diagram. CABG, coronary artery bypass grafting; CONSORT, Consolidated Standards of Reporting Trials.

Information on antithrombotic medication at discharge was sourced from SWEDEHEART and cross-referenced with the National Dispensed Drug Registry. Data on medication usage after discharge and over the first 12 months were obtained from the National Dispensed Drug Registry based on dispensing records. Trends in discharge treatment with antithrombotic therapy and treatment strategy over time were reported using numbers and percentages from 2011 to 2021. Trends in discharge treatment were also illustrated over years using 100% stacked column charts. Predictors of treatment with OACs versus no treatment with OACs at discharge, as well as predictors of treatment with DAPT+OAC versus SAPT+OAC, were assessed using logistic regression analysis. The duration of different antithrombotic treatment combinations and switches in therapy during the first 12 months after discharge was illustrated using a Sankey plot. Finally, data on the prescription of inadequate low-dose DOACs were calculated and presented (online supplemental table 2).

RESULTS

Baseline characteristics

The study included a total of 26574 patients (figure 1). Baseline characteristics categorised by treatment groups—SAPT+OAC, DAPT+OAC, only OAC (DOAC or warfarin), no OAC (SAPT or DAPT) or no antithrombotic treatment—are presented in table 1. Additionally, baseline characteristics for the DOAC and warfarin groups are reported separately in online supplemental table 3. Overall, the median age was 78 years (IQR 71–85), with 63% being male. A total of 78% had hypertension, 31% diabetes mellitus, 37% a history of prior MI, 15% a history of prior stroke, 23% heart failure and approximately 9% chronic kidney disease and chronic obstructive pulmonary disease, respectively. The prevalence of diabetes mellitus and prior MI was similar across the different treatment groups, while hypertension, prior stroke, heart failure, chronic kidney disease and chronic obstructive pulmonary disease tended to be more common among patients treated with only OAC as compared with those receiving other antithrombotic treatment regimens. Non-ST-elevation MI (NSTEMI) predominated over ST-elevation MI (STEMI) in all treatment groups. Prior cancer was almost twice as common in patients not receiving any antithrombotic agents compared with those receiving antithrombotic treatment. Most patients (97.7%) had a CHA_2DS_2-VASc score of 2 points or higher.

Trends in discharge antithrombotic treatment over the years 2011–2021

Similar to warfarin treatment at discharge, the use of only SAPT or DAPT has steadily decreased over the study period, shifting from being the predominant treatment strategy in 2011 to being administered to approximately 20% of the patients in 2021 (figure 2). Conversely, the prescription of DOACs has progressively increased over the years, primarily in combination with SAPT, but also when prescribed alone. Regarding the DAPT+DOAC combination, the usage has slightly decreased since its peak in 2019, constituting 13% in 2021. The proportion of patients receiving no antithrombotic treatment remained relatively stable at around 5% throughout the 10-year period, primarily due to failure to fill prescribed discharge medications. Trends in discharge antithrombotic treatment stratified by CHA_2DS_2-VASc score are presented in the online supplemental figure 1. With the introduction of DOACs, the prescription of inadequate low-dose DOACs began in 2013, peaked at 31% in 2016 and subsequently declined annually to 11% in 2021 (figure 3). A similar trend in the prescription of inadequate low dose DOACs was observed, regardless of whether prescribed as part of triple therapy or not (online supplemental figure 2).

Predictors of discharge treatment with OAC versus no OAC and DAPT+OAC versus SAPT+OAC

Predictors for the initiation of OAC treatment (DOAC or warfarin in any combination) in descending order included the year of discharge (admission year vs 2011),

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Table 1 Baseline demographics and characteristics

Characteristics	SAPT+OAC (n=7041)	DAPT+OAC (n=5013)	Only OAC (n=2645)	SAPT/DAPT (n=10 575)	No antithrombotic treatment (n=1300)	Combined (N=26 574)
Demographics						
Age, years, median (IQR)	79 (72–84)	76 (70–81)	82 (75–87)	79 (70–86)	81 (74–87)	78 (71–85)
Sex, male, n (%)	4405 (62.6)	3651 (72.8)	1287 (48.7)	6629 (62.7)	718 (55.2)	16 690 (62.8)
Medical history, n (%)						
Hypertension	5671 (80.5)	3951 (78.8)	2198 (83.1)	7884 (74.6)	1011 (77.8)	20 715 (78.0)
Diabetes mellitus	2312 (32.8)	1578 (31.5)	835 (31.6)	3151 (29.8)	428 (32.9)	8304 (31.2)
Prior MI	2522 (35.8)	1706 (34.0)	976 (36.9)	4112 (38.9)	442 (34.0)	9758 (36.7)
Prior stroke	1135 (16.1)	647 (12.9)	497 (18.8)	1551 (14.7)	249 (19.2)	4079 (15.3)
Prior systemic embolism	83 (1.2)	61 (1.2)	46 (1.7)	117 (1.1)	18 (1.4)	325 (1.2)
Heart failure	1606 (22.8)	952 (19.0)	783 (29.6)	2282 (21.6)	372 (28.6)	5995 (22.6)
Peripheral vascular disease	676 (9.6)	354 (7.1)	262 (9.9)	1053 (10.0)	149 (11.5)	2494 (9.4)
Chronic kidney disease	613 (8.7)	287 (5.7)	332 (12.6)	983 (9.3)	191 (14.7)	2406 (9.1)
COPD	591 (8.4)	318 (6.3)	318 (12.0)	879 (8.3)	145 (11.2)	2251 (8.5)
Liver disease	50 (0.7)	52 (1.0)	37 (1.4)	140 (1.3)	26 (2.0)	305 (1.1)
Cancer (within 3 years)	413 (5.9)	236 (4.7)	179 (6.8)	756 (7.1)	166 (12.8)	1750 (6.6)
Prior major bleeding	1013 (14.4)	552 (11.0)	428 (16.2)	1609 (15.2)	310 (23.8)	3912 (14.7)
Dementia	30 (0.4)	8 (0.2)	19 (0.7)	72 (0.7)	20 (1.5)	149 (0.6)
Index event and in-hospital course, n (%)						
Year of admission						
2011–2013	912 (13.0)	856 (17.1)	469 (17.7)	4129 (39.0)	353 (27.2)	6719 (25.3)
2014–2016	1666 (23.7)	1493 (29.8)	824 (31.2)	3355 (31.7)	438 (33.7)	7776 (29.3)
2017–2019	2363 (33.6)	1910 (38.1)	837 (31.6)	2186 (20.7)	317 (24.4)	7613 (28.6)
2020–2021	2100 (29.8)	754 (15.0)	515 (19.5)	905 (8.6)	192 (14.8)	4466 (16.8)
NSTEMI	5195 (73.8)	3240 (64.6)	2414 (91.3)	7370 (69.7)	1050 (80.8)	19 269 (72.5)
STEMI	1846 (26.2)	1773 (35.4)	231 (8.7)	3205 (30.3)	250 (19.2)	7305 (27.5)
New-onset AF	3277 (46.5)	2644 (52.7)	993 (37.5)	5476 (51.8)	573 (44.1)	12 963 (48.8)
Creatinine, median (IQR)	89 (73–112)	87 (73–105)	92 (74–119)	90 (73–114)	98 (75–133)	89 (73–113)
Coronary angiography	5438 (77.2)	4767 (95.1)	1065 (40.3)	7153 (67.6)	496 (38.2)	18 919 (71.2)
PCI	4232 (60.1)	4532 (90.4)	278 (10.5)	5887 (55.7)	270 (20.8)	15 199 (57.2)
CHA_2DS_2-VASc score						
1 point	87 (1.2)	93 (1.9)	21 (0.8)	401 (3.8)	20 (1.5)	622 (2.3)
2 points	389 (5.5)	429 (8.6)	78 (2.9)	845 (8.0)	63 (4.8)	1804 (6.8)
≥3 points	6565 (93.2)	4491 (89.6)	2546 (96.3)	9329 (88.2)	1217 (93.6)	24 148 (90.9)
Medication at discharge, n (%)						
Acetylsalicylic acid	1826 (25.9)	5013 (100.0)	0 (0.0)	9663 (91.4)	0 (0.0)	16 502 (62.1)
$P2Y_{12}$ inhibitors	5215 (74.1)	5013 (100.0)	0 (0.0)	8676 (82.0)	0 (0.0)	18 904 (71.1)
Warfarin	2497 (35.5)	2425 (48.4)	1168 (44.2)	0 (0.0)	0 (0.0)	6090 (22.9)
Dabigatran	381 (5.4)	241 (4.8)	96 (3.6)	0 (0.0)	0 (0.0)	718 (2.7)
Rivaroxaban	704 (10.0)	411 (8.2)	228 (8.6)	0 (0.0)	0 (0.0)	1343 (5.1)
Apixaban	3392 (48.2)	1904 (38.0)	1120 (42.3)	0 (0.0)	0 (0.0)	6416 (24.1)
Edoxaban	67 (1.0)	32 (0.6)	33 (1.2)	0 (0.0)	0 (0.0)	132 (0.5)

Continued

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Table 1 Continued

Characteristics	SAPT+OAC (n=7041)	DAPT+OAC (n=5013)	Only OAC (n=2645)	SAPT/DAPT (n=10 575)	No antithrombotic treatment (n=1300)	Combined (N=26 574)

Values are in median (IQR) for continuous variables and numbers (%) for categorical variables.Creatinine is presented in µmol/L.
AF, atrial fibrillation; CHA2DS2-VASc, congestive heart failure, hypertension, age, diabetes, stroke, vascular disease, sex; COPD, chronic obstructive pulmonary disease; DAPT, dual antiplatelet therapy; MI, myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; OAC, oral anticoagulant; PCI, percutaneous coronary intervention; SAPT, single antiplatelet therapy; STEMI, ST-segment elevation myocardial infarction.

coronary angiography during index hospitalisation, in-hospital PCI, prior systemic embolism, heart failure, hypertension and prior stroke. Conversely, dementia, liver disease, cancer, STEMI, prior major bleeding, peripheral vascular disease, chronic kidney disease, chronic obstructive pulmonary disease and prior MI were in descending order predictors of decreased likelihood of OAC initiation at discharge (table 2). Predictors of treatment with DAPT+OAC versus SAPT+OAC at discharge, regardless of the type of OAC, are presented in the online supplemental table 4.

Duration of different antithrombotic treatment combinations during the first year after discharge

The duration of different combinations of antithrombotic agents, including DOACs or warfarin, during the first year postdischarge for all patients is illustrated using a Sankey plot (figure 4). Throughout the study period, one of the most common antithrombotic treatment combinations during the first year postdischarge consisted of only SAPT or DAPT. Few patients discharged on SAPT or DAPT started treatment with OACs later during follow-up. Treatment with DAPT+OAC most often de-escalated to SAPT+OAC at 3–6 months. Patients receiving SAPT+OAC at discharge also tended to de-escalate their treatment from 3 months up to 12 months, mainly by transition to OAC monotherapy.

DISCUSSION

Between 2011 and 2021, there has been a shift in medical practice and the antithrombotic strategies used for patients with acute MI and concurrent AF in Sweden. The overall use of OACs has progressively increased, with DOACs replacing warfarin as the default strategy in recent years, driven by evolving clinical guidelines

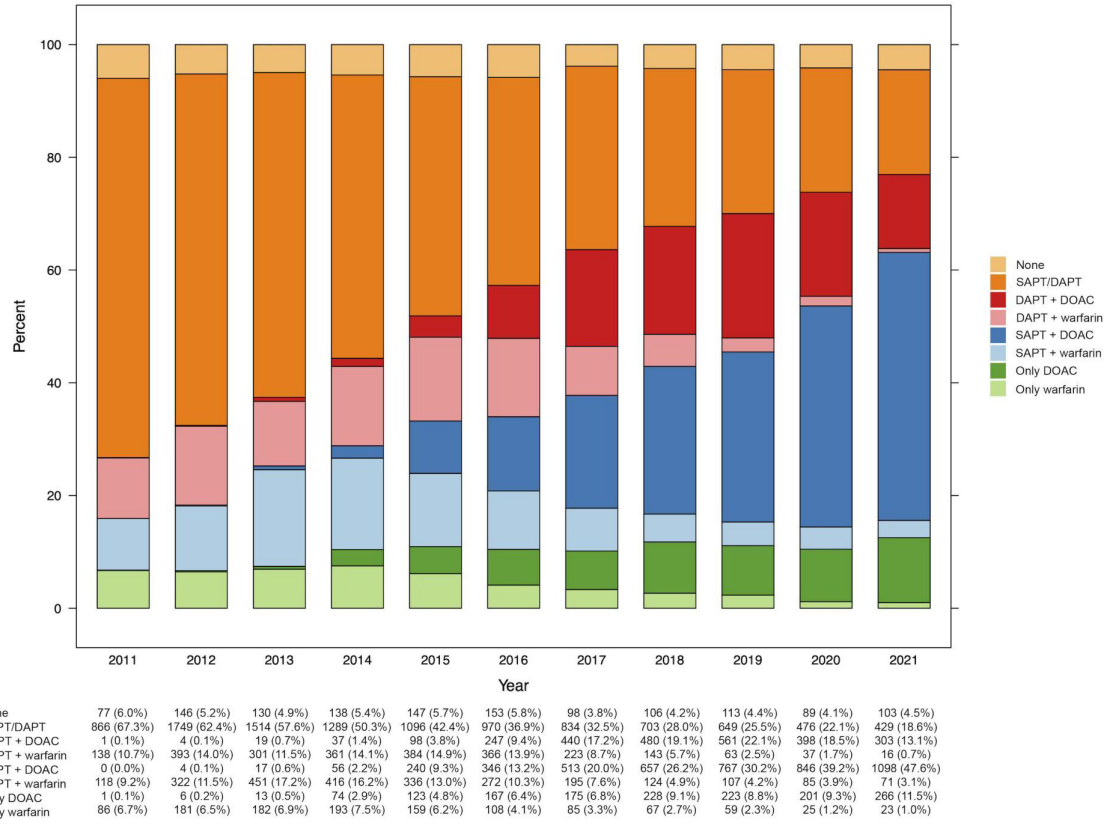

Figure 2 Trends in discharge antithrombotic treatment between 2011 and 2021. DAPT, dual antiplatelet therapy; DOAC, direct oral anticoagulant; SAPT, single antiplatelet therapy.

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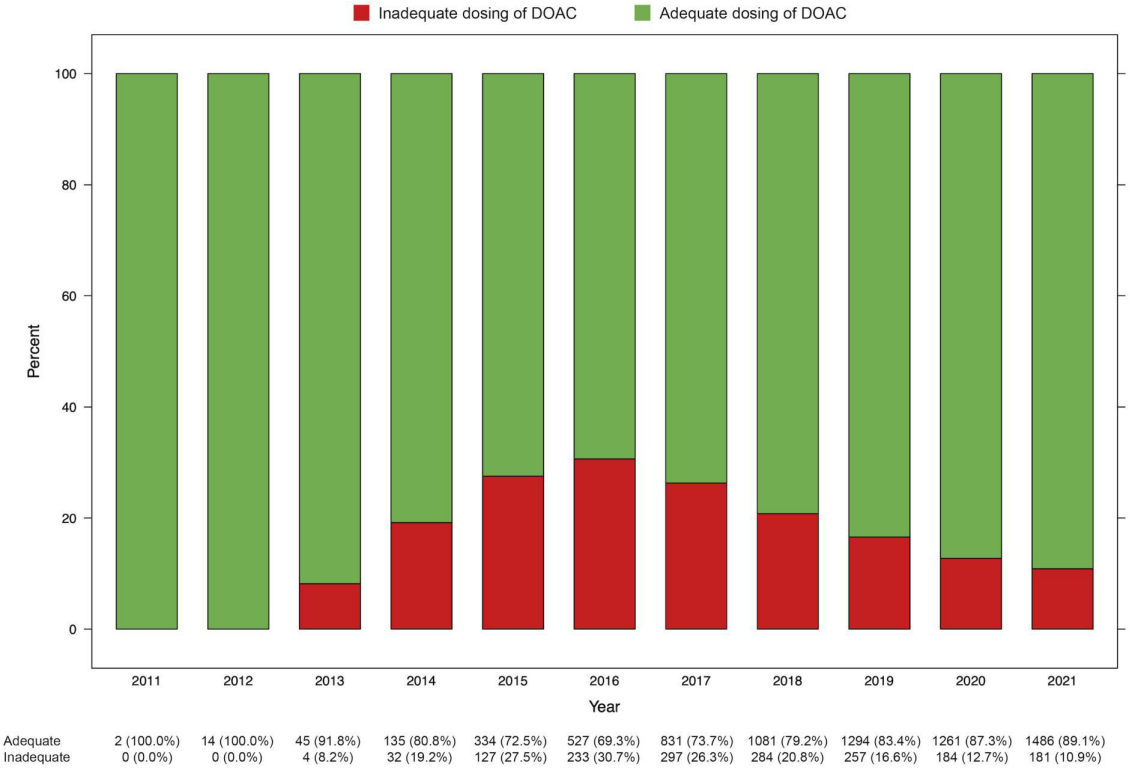

Figure 3 Trends in inadequate low dosing of DOAC at discharge between 2011 and 2021. DOAC, direct oral anticoagulant.

and growing clinical experience. This trend is further supported by the fact that the year of hospitalisation is the most significant factor associated with an increasing likelihood of receiving OAC treatment at discharge. Other significant predictors of OAC treatment included coronary angiography and PCI. Conversely, conditions such as dementia, liver disease and cancer were associated with a reduced likelihood of OAC initiation, reflecting concerns about bleeding risks and patient frailty. While DAPT+OAC continues to represent a significant proportion, the use of triple therapy has declined in recent years. A concerning trend emerged with the introduction of DOACs, where the prescription of inadequate low-dose DOACs for patients with MI and concomitant AF began in 2013, peaked in 2016, but has since declined, though it remains an issue. Patients discharged on DAPT+OAC or SAPT+OAC often de-escalated treatment by terminating one antiplatelet drug during the first 12 months of follow-up, in line with clinical practice guidelines. However, few patients discharged on only SAPT or DAPT started OAC treatment within the first 12 months of follow-up, despite the majority having a CHA_2DS_2-VASc score of ≥2 points.

A history of AF or new-onset AF is a common finding among patients with MI, affecting approximately 10–20% of all patients with MI-related hospitalisations.[15 16] Regardless of the type, AF in patients with MI is associated with an increased risk of stroke, recurrent MI and both cardiovascular (CV) and non-CV death during short- and long-term follow-up.[15 17] Additionally, patients with MI and AF, in comparison with those without AF, have several additional comorbidities that increase the risk of mortality, CV outcomes and bleeding events.[15–17]

In patients with AF and an increased risk of stroke, OAC therapy lowers the risk of ischaemic stroke and systemic embolism but is associated with a higher risk of bleeding.[18] In patients with MI and concomitant AF who require DAPT and OAC, the optimal antithrombotic regimen and its duration remain unclear. Recent trials have tested the safety of combining DOACs with different antiplatelet agents in patients with MI and concomitant AF. However, all these trials were powered to address the safety in terms of bleeding rather than the risk of specific ischaemic outcomes.[4–8]

In patients with AF undergoing PCI for acute or stable coronary artery disease, data suggest that a SAPT+OAC strategy is preferable to DAPT+OAC due to a reduced risk of bleeding.[4] In fact, SAPT rather than DAPT has been the common regimen of antiplatelet therapy in combination with OACs since 2013 when the WOEST (What is the Optimal antiplatElet and anticoagulant therapy in patients with oral anticoagulation and coronary StenTing) trial demonstrated a significant reduction in bleeding complications without increasing thrombotic events with dual therapy including clopidogrel rather than triple therapy with clopidogrel plus aspirin in patients with OAC undergoing PCI.[19] The PIONEER AF-PCI (OPen-Label, Randomized, Controlled, Multicenter Study ExplorIng TwO TreatmeNt StratEgiEs

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Table 2 Predictors of treatment with oral anticoagulants versus no treatment with oral anticoagulants at discharge

Characteristics	OR (95% CI)
Demographics	
Age, Q3 (85 years) vs Q1 (71 years)	1.00 (0.93 to 1.08)
Age, male versus female	1.00 (0.94 to 1.06)
Medical history	
Hypertension	1.24 (1.16 to 1.33)
Diabetes mellitus	1.00 (0.95 to 1.07)
Prior MI	0.91 (0.85 to 0.96)
Prior stroke	1.18 (1.09 to 1.27)
Prior systemic embolism	1.40 (1.09 to 1.79)
Heart failure	1.28 (1.19 to 1.37)
Peripheral vascular disease	0.86 (0.78 to 0.94)
Chronic kidney disease	0.90 (0.81 to 1.00)
Chronic obstructive pulmonary disease	0.90 (0.82 to 0.99)
Liver disease	0.59 (0.46 to 0.76)
Cancer (within 3 years)	0.73 (0.65 to 0.81)
Prior major bleeding	0.81 (0.75 to 0.88)
Dementia	0.53 (0.37 to 0.75)
Index event and in-hospital course	
Admission year, 2021 vs 2011*	9.31 (7.92 to 10.95)
STEMI vs NSTEMI	0.74 (0.70 to 0.79)
Creatinine, Q3 (113 µmol/L) vs Q1 (73 µmol/L)	0.96 (0.90 to 1.02)
Only coronary angiography	1.53 (1.40 to 1.68)
PCI	1.49 (1.39 to 1.61)

*2012 vs 2011 (OR 1.27 (1.10–1.48)), 2013 vs 2011 (OR 1.60 (1.38–1.86)), 2014 vs 2011 (OR 2.17 (1.87–2.52)), 2015 vs 2011 (OR 2.99 (2.58–3.48)), 2016 vs 2011 (OR 3.68 (3.17–4.28)), 2017 vs 2011 (OR 4.80 (4.12–5.58)), 2018 vs 2011 (OR 5.85 (5.02–6.82)), 2019 vs 2011 (OR 6.56 (5.63–7.66)), 2020 vs 2011 (OR 7.81 (6.65–9.17)).
MI, myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; Q1, quartile 1; Q3, quartile 3; STEMI, ST-segment elevation myocardial infarction.

of Rivaroxaban and a Dose-Adjusted Oral Vitamin K Antagonist Treatment Strategy in Subjects with Atrial Fibrillation who Undergo Percutaneous Coronary Intervention) trial presented in 2016, observed a lower bleeding risk with rivaroxaban combined with SAPT (a $P2Y_{12}$ inhibitor), compared with triple therapy with either rivaroxaban or warfarin, without increasing the thromboembolic risk.[5] Similarly, the RE-DUAL PCI (Randomized Evaluation of Dual Antithrombotic Therapy with Dabigatran versus Triple Therapy with Warfarin in Patients with Nonvalvular Atrial Fibrillation Undergoing Percutaneous Coronary Intervention) trial in 2017 showed lower bleeding risks with a dual antithrombotic therapy including dabigatran plus SAPT (a $P2Y_{12}$ inhibitor) compared with triple therapy with warfarin, a $P2Y_{12}$ inhibitor and aspirin.[6] In the AUGUSTUS trial published in 2019, patients with AF receiving $P2Y_{12}$ inhibition, with or without aspirin, following a recent acute coronary syndrome or PCI, experienced fewer bleeding events with apixaban compared with warfarin, without an increase in ischaemic events.[7] Consistent with these findings, the ENTRUST-AF PCI (EdoxabaN TReatment versUS VKA in paTients with AF undergoing PCI) trial in 2019 showed that a regimen including edoxaban and a $P2Y_{12}$ inhibitor was non-inferior to triple therapy, in patients with AF and PCI for acute or stable coronary artery disease in terms of bleeding.[8] Collectively, these studies show that a SAPT+OAC strategy seems to be a safer option in terms of bleeding risks than DAPT+OAC, without an increased risk of thromboembolic events, although the studies were not large enough to conclusively test the risk of thromboembolic outcomes.[20] These findings have also resulted in updated clinical practice guidelines and consensus documents since then recommending triple therapy for a short period of time following an MI and/or PCI, followed by SAPT+OAC therapy.[21–23]

By analysing patients with MI and concomitant AF in Sweden between 2011 and 2021, we observed a clear

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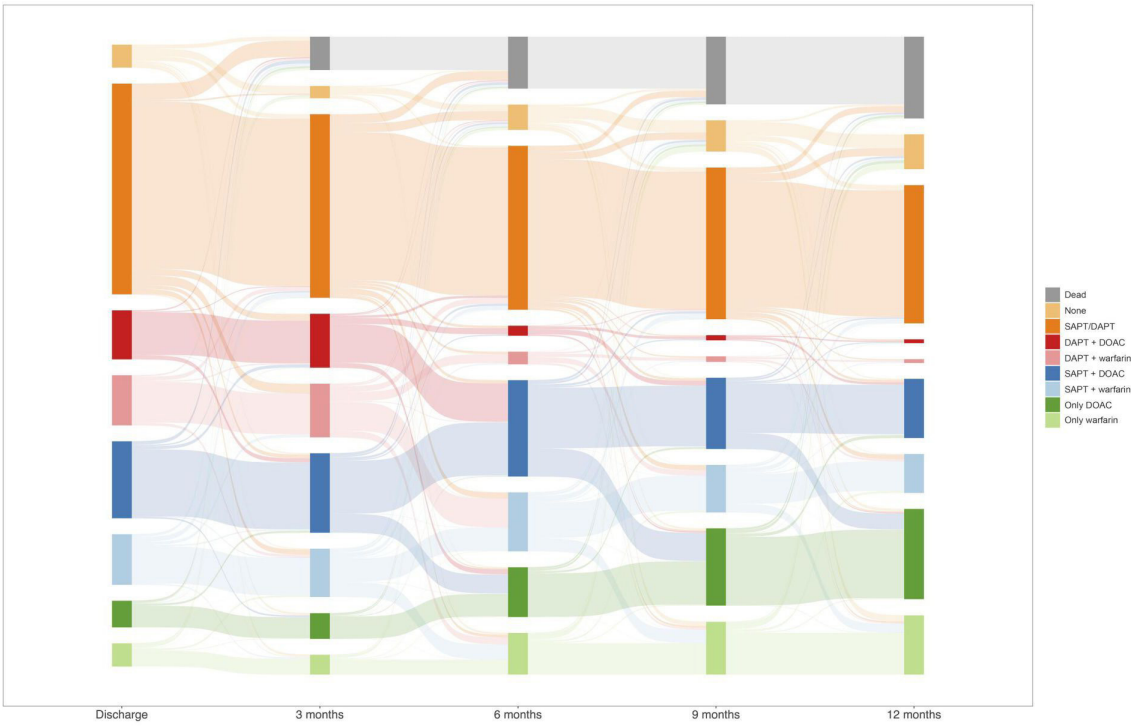

Figure 4 Duration of different antithrombotic treatment combinations during the first 12 months after discharge. DAPT, dual antiplatelet therapy; DOAC, direct oral anticoagulant; SAPT, single antiplatelet therapy.

shift in medical practice over time with increased utilisation of OACs in general and DOACs in particular, the latter often in combination with SAPT or DAPT. This pattern and the use of different antithrombotic combinations highlight the uncertainty that can occur in clinical practice when robust evidence is lacking. With new evidence and updated guidelines as presented above, this study documented nationwide shifts in medical practice. Few studies have assessed the impact of trial findings and updated guidelines on their implementation in medical practice.[24–27] However, this study found a clear impact on medical practice in patients with MI and concomitant AF in Sweden based on updated evidence and clinical practice guidelines. While guideline implementation has been shown to improve outcomes and reduce mortality,[28] further studies are needed to determine if this applies to patients with MI and concomitant AF.

Despite increased experience with DOACs, a significant proportion of patients with AF hospitalised for MI in Sweden received inadequately low doses of DOACs at discharge. Although this trend has declined since 2016, a disproportionately large number of patients remains undertreated, with more than 10% receiving an inadequate low dose of DOAC in 2021. Notably, the proportion of inadequate low dosing was similar over time between patients receiving triple therapy and those not receiving triple therapy. This finding has previously been observed in other countries and is concerning, as unnecessarily low dosages of DOACs have been associated with an increased risk of stroke.[29 30] The reasons for the inadequate low dosing of DOACs in this population remain unknown, but it can be speculated that fear of side effects, mainly bleeding complications, may play an important role.

This real-world observational descriptive registry study in Sweden contributes to an increased understanding of the current antithrombotic treatment strategies used in patients with MI and concomitant AF. The unique possibility of linking Swedish national quality registries and administrative health databases provides high-quality representative data on the treatment with antithrombotic agents at a national level. However, there are some limitations that merit consideration. First, we were only able to report drug treatment at discharge cross-referenced with the National Dispensed Drug Register in numbers and could not provide information regarding the provider's rationale for treatment choice. Second, information about drug treatment during follow-up is only available using dispense data from the National Dispensed Drug Register. As such, we were not able to provide exact details about the treatment provided to patients during follow-up after discharge but relied on dispense data to estimate treatment duration and switch in treatment during follow-up. Third, we have limited information about patient adherence to specific treatment regimens, except for drug prescriptions being dispensed at discharge and during follow-up according to the National Dispensed Drug Register. Fourth, we analysed all DOACs collectively,

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despite the fact that the different DOACs have not been tested head-to-head. This represents an important limitation, as the various DOACs exhibit different risk profiles that may influence physician preference. Finally, although we adjusted for relevant covariates in the logistic regression analysis, residual confounding may still be present, and we are not always able to fully understand or explain the observed relationships, for example, the lower likelihood of patients with STEMI versus NSTEMI receiving OACs at discharge.

CONCLUSIONS

In Sweden, the use of OAC, particularly DOAC, at discharge for patients with MI and concomitant AF steadily increased between 2011 and 2021, predominantly in combination with SAPT or DAPT. Despite growing clinical experience, a significant number of patients still receive either no anticoagulation or, in some cases, inadequately low doses of DOAC. The use of SAPT or DAPT alone has declined in recent years, yet many patients with high CHA_2DS_2-VASc scores continue to be discharged with no OAC treatment. Therefore, the dissemination and implementation of guideline recommendations, along with regular reporting on adherence, remain essential for optimising treatment in this patient population.

Contributors GB and AM conceived and designed the study. GB, JAl, CH and SJ contributed to acquiring the data. LL curated the data and conducted the analysis. GB verified the underlying data. GB and JAu drafted the article. All authors provided critical interpretation and revision of the article. All authors had full access to all the study data and accept responsibility for submitting the article for publication. GB is the guarantor.

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