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Trends in antidiabetes medication use among hospitalised patients with type 2 diabetes: a retrospective single-centre cohort study

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ABSTRACT

Objectives Novel antidiabetes medications with proven cardiovascular or renal benefit, such as sodium-glucose cotransporter-2 inhibitors (SGLT-2i) and glucagon-like peptide 1 receptor agonists (GLP-1 RA), have been introduced to the market. This study explored the 4-year trends of antidiabetes medication use among medical hospitalisations with type 2 diabetes (T2D).

Design Retrospective cohort study.

Setting Tertiary care hospital in Switzerland.

Participants 4695 adult hospitalisations with T2D and prevalent or incident use of one of the following antidiabetes medications (metformin, dipeptidyl peptidase-4 inhibitors (DPP-4i), sulfonylureas, GLP-1 RA, SGLT-2i, short-acting insulin or long-acting insulin), identified using electronic health record data. Quarterly trends in use of antidiabetes medications were plotted overall and stratified by cardiovascular disease (CVD) and chronic kidney disease (CKD).

Results We observed a stable trend in the proportion of hospitalisations with T2D who received any antidiabetes medication (from 77.6% during 2019 to 78% in 2022; p for trend=0.97). In prevalent users, the largest increase in use was found for SGLT-2i (from 7.4% in 2019 to 21.8% in 2022; p for trend <0.01), the strongest decrease was observed for sulfonylureas (from 11.4% in 2019 to 7.2% in 2022; p for trend <0.01). Among incident users, SGLT-2i were the most frequently newly prescribed antidiabetes medication with an increase from 26% in 2019 to 56.1% in 2022 (p for trend <0.01). Between hospital admission and discharge, SGLT-2i also accounted for the largest increase in prescriptions (+5.1%; p<0.01).

Conclusions These real-world data from 2019 to 2022 demonstrate a significant shift in antidiabetes medications within the in-hospital setting, with decreased use of sulfonylureas and increased prescriptions of SGLT-2i, especially in hospitalisations with CVD or CKD. This trend aligns with international guidelines and indicates swift adaptation by healthcare providers, signalling a move towards more effective diabetes management.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study cohort is current, with data extending up to the end of 2022.
⇒ This research is among the limited studies examining the prescription patterns of antidiabetes medications in hospital settings, both within Switzerland and internationally.
⇒ The external validity of this study is limited due to its design as a single-centre cohort.
⇒ Our analysis was confined to in-hospital data, and therefore, does not extend to outpatients.
⇒ The lack of clinical and laboratory data, as well as unspecified reasons for prescribing or deprescribing medications, restricts the conclusions that can be drawn from this study.

INTRODUCTION

The prevalence of type 2 diabetes (T2D) is rapidly increasing across the globe. According to the International Diabetes Federation's worldwide/global Diabetes Atlas, the estimated number of adults living with T2D quadrupled from 151 million in the year 2000[1] to 483 million in 2021.[2] This also imposes a relevant social economic burden of direct costs from diabetes of US$966 billion globally.[2] This burden is further compounded by significant microvascular (diabetic kidney disease, diabetic neuropathy and retinopathy) and macrovascular complications (cardiovascular and peripheral artery disease), which are the leading cause of morbidity and mortality in people with diabetes.[3] To reduce these complications, it is essential to achieve certain glycaemic targets, for which numerous antidiabetes medications have been developed in recent years. Traditionally, metformin has been recommended as first-line antidiabetes therapy due to its high efficacy in lowering haemoglobin A1c, beneficial safety profile, low cost and weight neutrality.[4] According to the newest American Diabetes Association (ADA) guidelines, more recent medications, notably glucagon-like peptide 1 receptor agonists (GLP-1 RA) and sodium-glucose cotransporter-2 inhibitors (SGLT-2i),

may be an appropriate first-line therapy too, independent of metformin use.[4] Particularly in people with established or high risk of cardiovascular disease (CVD) or chronic kidney disease (CKD), those medications have evident benefits for cardiovascular and renal outcomes independent of metformin use.[5–7]

As prescribing trends of antidiabetes medications among hospitalised patients are widely lacking, the aim of this study was to assess the trends in use of different antidiabetes medications in medical hospitalisations with T2D. We sought to determine whether these trends are aligning with the recommendations from international practice guidelines.

METHODS

Data source and study design

We performed a retrospective cohort study that was conducted at the Cantonal Hospital Aarau, a tertiary, 500-bed hospital in Switzerland, with approximately 6000 annual medical admissions. Eligible admissions to the Medical University Clinic were extracted from the electronic health record between January 2019 and December 2022. These data included information of medications on hospital admission and discharge, inpatient diagnoses and baseline demographics among others. We defined a cohort of any antidiabetes medication users and further defined a subcohort in which hospitalisations were required to be incident users only. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology reporting guideline.[8]

Study population and medications of interest

Hospitalisation of patients who were at least 18 years of age, hospitalised on a medical ward and with a prevalent diagnosis of T2D were included. Exclusion criteria included any other type of diabetes and in-hospital death. The exclusion of in-hospital deaths was implemented because the end-of-life setting represents a distinct clinical context in which any changes in medication between admission and death are driven by the circumstance of death rather than by the physician's clinical judgement. We did not apply any further exclusion criteria to allow for high generalisability of our results. Within the study population, we identified two cohorts to examine trends in (1) a cohort of any (prevalent or incident) users of antidiabetes medications ('user' cohort) and (2) a cohort of incident users ('incident user' cohort) only. The 'user' cohort included all hospitalisations, who used any antidiabetes medication on hospital admission or at discharge or both. 'Incident users', as a subset of the 'user' cohort, referred to hospitalisations who were newly prescribed to an antidiabetes medication during the hospitalisation.

We considered seven antidiabetes medication classes including metformin, DPP-4i (ie, sitagliptin, vildagliptin, saxagliptin, linagliptin), GLP-1 RA (ie, semaglutide, liraglutide, dulaglutide, lixisenatide or exenatide), SGLT-2i (ie, dapagliflozin, empagliflozin, canagliflozin or ertugliflozin), short-acting insulins (ie, insulin lispro, insulin aspart, regular human insulin), long-acting insulins (ie, insulin glargine, insulin detemir, insulin degludec) and sulfonylureas (ie, glibenclamid, gliclazide, glimepirid). Other, rarely prescribed antidiabetes medication classes, such as glitazones, were not considered for this analysis.

Patient characteristics

Patient characteristics at baseline were measured on hospital admission. Covariates of interest included demographics (age, sex, Swiss citizenship, insurance), diabetes-associated complications, comorbidities and use of other medications. All comorbidities were identified by International Statistical Classification of Diseases and Related Health Problems (ICD-10 codes).

Statistical analysis

Baseline characteristics were tabulated for the overall cohort. The 4-year study period was segmented into 16 quarters (3-month time intervals, respectively) and hospitalisations were assigned to one of these intervals based on their calendar time of hospital discharge. Hospitalisations could have contributed to more than one antidiabetes medication if the inclusion criteria were met. Since the unit of analysis was any single hospitalisation, one single patient could have contributed to more than one hospitalisation. Any use of antidiabetes medication class was calculated as the percentage of all patients being prescribed to a prevalent or incident antidiabetes medication on hospital admission or at discharge, among the individuals with T2D who qualified for cohort entry for that specific 3-month interval between 2019 and 2022. Incident use of each antidiabetes medication class was defined as the percentage of all patients being newly prescribed to that class during the hospitalisation, among the individuals with T2D who qualified for cohort entry for that specific 3-month interval between 2019 and 2022. For illustration, we used *lowess*, a locally weighted polynomial regression model designed to generate smooth curves through the set of data points. The Cochran-Armitage test was used to calculate p for trend over the years. P values for dependent variables (comparison between hospital admission and discharge) were calculated using the McNemar test. A logistic regression model was used to identify predictors for incident use or deprescription of the different antidiabetes medication classes. We used Sankey diagrams to illustrate changes in medication use between hospital admission and discharge. All analyses were performed among the overall cohort and, as a subgroup analysis, stratified by the presence of CVD or CKD with Stata V.17.0 (StataCorp).

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Table 1 Baseline characteristics of hospitalisations with type 2 diabetes, overall and by study year

	Total	2019	2020	2021	2022
	N=4695	N=1208	N=1148	N=1191	N=1148
Female sex (%)	1679 (35.8)	450 (37.3)	403 (35.1)	440 (36.9)	386 (33.6)
Age, years, mean (SD)	73 (11)	74 (11)	73 (12)	72 (12)	73 (11)
Stay before admission (%)					
At home	3502 (74.6)	886 (73.3)	874 (76.1)	901 (75.7)	841 (73.3)
Insurance (%)					
Supplementary insurance	662 (14.1)	185 (15.3)	152 (13.2)	168 (14.1)	157 (13.7)
General insurance	4033 (85.9)	1023 (84.7)	996 (86.8)	1023 (85.9)	991 (86.3)
Swiss citizen	3434 (73.1)	916 (75.8)	815 (71.0)	858 (72.0)	845 (73.6)
Diabetes-associated complications (%)					
Diabetic neuropathy	490 (10.4)	137 (11.3)	122 (10.6)	98 (8.2)	133 (11.6)
Diabetic nephropathy	791 (16.8)	234 (19.4)	175 (15.2)	180 (15.1)	202 (17.6)
Diabetic retinopathy	50 (1.1)	8 (0.7)	11 (1.0)	3 (0.3)	28 (2.4)
Comorbidities (%)					
Obesity	267 (5.7)	29 (2.4)	36 (3.1)	63 (5.3)	139 (12.1)
Dyslipidaemia	2120 (45.2)	553 (45.8)	507 (44.2)	527 (44.2)	533 (46.4)
Hypertension	2438 (51.9)	604 (50.0)	605 (52.7)	675 (56.7)	554 (48.3)
Myocardial infarction	532 (11.3)	149 (12.3)	132 (11.5)	109 (9.2)	142 (12.4)
Cardiovascular disease*	2414 (51.4)	659 (54.6)	561 (48.9)	575 (48.3)	619 (53.9)
Stroke	472 (10.1)	123 (10.2)	105 (9.1)	123 (10.3)	121 (10.5)
Peripheral artery disease	641 (13.7)	183 (15.1)	147 (12.8)	140 (11.8)	171 (14.9)
Cerebral atherosclerosis	217 (4.6)	32 (2.6)	35 (3.0)	63 (5.3)	87 (7.6)
Heart failure	854 (18.2)	198 (16.4)	170 (14.8)	215 (18.1)	271 (23.6)
Chronic kidney disease	1821 (38.8)	502 (41.6)	437 (38.1)	446 (37.4)	436 (38.0)
Obstructive sleep apnoea syndrome	296 (6.3)	81 (6.7)	69 (6.0)	74 (6.2)	72 (6.3)
Atrial fibrillation and flutter	1186 (25.3)	318 (26.3)	260 (22.6)	311 (26.1)	297 (25.9)
Liver disease	246 (5.2)	70 (5.8)	67 (5.8)	50 (4.2)	59 (5.1)
Pneumonia	483 (10.3)	70 (5.8)	139 (12.1)	132 (11.1)	142 (12.4)
Solid cancer	539 (11.5)	121 (10.0)	128 (11.1)	135 (11.3)	155 (13.5)
Haematological malignancy	154 (3.3)	35 (2.9)	37 (3.2)	33 (2.8)	49 (4.3)
Depression	95 (2.0)	30 (2.5)	24 (2.1)	12 (1.0)	29 (2.5)
Dementia	35 (0.7)	9 (0.7)	11 (1.0)	8 (0.7)	7 (0.6)
Medication on hospital admission (%)					
ACE inhibitors	917 (19.5)	236 (19.5)	244 (21.3)	229 (19.2)	208 (18.1)
Angiotensin receptor blockers	723 (15.4)	176 (14.6)	177 (15.4)	187 (15.7)	183 (15.9)
Beta-blockers	1977 (42.1)	513 (42.5)	475 (41.4)	509 (42.7)	480 (41.8)
Calcium antagonists	1023 (21.8)	222 (18.4)	265 (23.1)	283 (23.8)	253 (22.0)
Diuretics	1669 (35.5)	454 (37.6)	419 (36.5)	397 (33.3)	399 (34.8)
Cholesterol-lowering drugs	2345 (49.9)	593 (49.1)	570 (49.7)	620 (52.1)	562 (49.0)
Antiplatelets	2928 (62.4)	758 (62.7)	717 (62.5)	746 (62.6)	707 (61.6)
Anticoagulants	1921 (40.9)	525 (43.5)	469 (40.9)	484 (40.6)	443 (38.6)
Opiates	543 (11.6)	149 (12.3)	133 (11.6)	126 (10.6)	135 (11.8)
Non-opioid analgesics	1070 (22.8)	273 (22.6)	289 (25.2)	241 (20.2)	267 (23.3)
Antidepressants	868 (18.5)	215 (17.8)	220 (19.2)	218 (18.3)	215 (18.7)

*The diagnosis of cardiovascular disease is a composite of heart failure, one or more myocardial infarctions, ischaemic heart disease and coronary atherosclerosis.

RESULTS

Baseline characteristics

Of 31 627 medical hospitalisations between January 2019 and December 2022, we excluded 2808 declining general informed consent, 22 504 without a diagnosis of T2D and 1620 due to in-hospital death (online supplemental figure 1). Thus, we had 4695 hospitalisations with T2D available for our analysis. Overall, 35.8% of the hospitalisations were female, the median age was 73 years, 74.6% were living at home before hospital admission, 85.9% had a general insurance and 73.1% were Swiss citizens. Diabetic nephropathy was the most prevalent diabetes-associated complication, while dyslipidaemia (45%), arterial hypertension (52%), CVD (51%) and CKD (39%) were the most common comorbidities. On hospital admission, the most frequently used co-medications were beta-blockers, cholesterol-lowering drugs, antiplatelets and anticoagulants. All baseline characteristics are provided in table 1.

Trends in utilisation of antidiabetes medications from 2019 to 2022

Between 2019 and 2022, the proportion of hospitalisations with T2D who received any antidiabetes medication did not relevantly change from 77.6% in 2019 to 78% in 2022 (p for trend=0.97). Trends at time point of hospital discharge were comparable (p for trend=0.98). The proportion of hospitalisations receiving two or more antidiabetes medications increased non-significantly over the years (p for trend on admission=0.62; at discharge=0.36) (table 2, figure 1A).

Among the 'user' cohort, SGLT-2i showed the largest increase in utilisation at both hospital admission and discharge (from 7.4% in 2019 to 21.8% in 2022 on admission; from 10.8% to 29.4% at discharge; p for trend <0.01, respectively), whereas the strongest decrease in use was observed for sulfonylureas (from 11.4% in 2019 to 7.2% in 2022 on admission and discharge; p for trend <0.01,

Table 2 Proportions of hospitalisations with antidiabetes medications on hospital admission and at discharge 2019 vs 2022

	Admission			Discharge		
	Study year		P for trend	Study year		P for trend
Intensity of antidiabetes treatment	2019	2022	2019–2022	2019	2022	2019–2022
Number of hospitalisations	1208	1148		1208	1148	
User						
Any antidiabetes medication, no. (%)	937 (77.6)	896 (78.0)	0.97	966 (80.0)	918 (80.0)	0.98
Use of 1 antidiabetes medication*	329 (35.1)	291 (32.5)	0.59	319 (33.0)	272 (29.6)	0.31
Use of ≥2 antidiabetes medications*	608 (64.9)	605 (67.5)	0.62	647 (67.0)	646 (70.4)	0.36
Antidiabetes medication classes, no. (%)†						
Use of short-acting insulin	325 (26.9)	276 (24.0)	0.06	323 (26.7)	279 (24.3)	0.10
Use of long-acting insulin	458 (37.9)	443 (38.6)	1.00	454 (37.6)	444 (38.7)	0.85
Use of metformin	486 (40.2)	486 (42.3)	0.34	493 (40.8)	479 (41.7)	0.67
Use of GLP-1 RA	49 (4.1)	88 (7.7)	<0.01	55 (4.6)	100 (8.7)	<0.01
Use of SGLT-2 inhibitors	89 (7.4)	250 (21.8)	<0.01	131 (10.8)	337 (29.4)	<0.01
Use of DPP-4 inhibitors	337 (27.9)	287 (25.0)	0.06	375 (31.0)	297 (25.9)	<0.01
Use of sulfonylurea	138 (11.4)	83 (7.2)	<0.01	138 (11.4)	83 (7.2)	<0.01
Incident user						
Any antidiabetes medication, no. (%)	N/A	N/A	N/A	192 (15.9)	214 (18.6)	0.03
Antidiabetes medication classes, no. (%)‡						
Incident use of short-acting insulin	N/A	N/A	N/A	1 (0.5)	5 (2.3)	0.09
Incident use of long-acting insulin	N/A	N/A	N/A	0 (0.0)	3 (1.4)	0.10
Incident use of metformin	N/A	N/A	N/A	87 (45.3)	78 (36.4)	0.06
Incident use of GLP-1 RA	N/A	N/A	N/A	11 (5.7)	20 (9.3)	0.49
Incident use of SGLT-2 inhibitors	N/A	N/A	N/A	50 (26.0)	120 (56.1)	<0.01
Incident use of DPP-4 inhibitors	N/A	N/A	N/A	80 (41.7)	52 (24.3)	<0.01
Incident use of sulfonylurea	N/A	N/A	N/A	(0.0)	(0.0)	N/A
No use, no. (%)	271 (22.4)	252 (22.0)	0.97	242 (20.0)	230 (20.0)	0.98

*Percentages are calculated by the number of users with a certain amount of antidiabetes medication divided by the number of any users.
†Percentages are calculated by the number of any users of a specific medication class divided by the number of cases.
‡Percentages are calculated by the number of incident users of a specific medication class divided by the number of incident antidiabetes medication users.
DPP-4, dipeptidyl peptidase-4; GLP-1 RA, glucagon-like peptide-1 receptor agonist; N/A, not available; SGLT-2, sodium–glucose cotransporter-2.

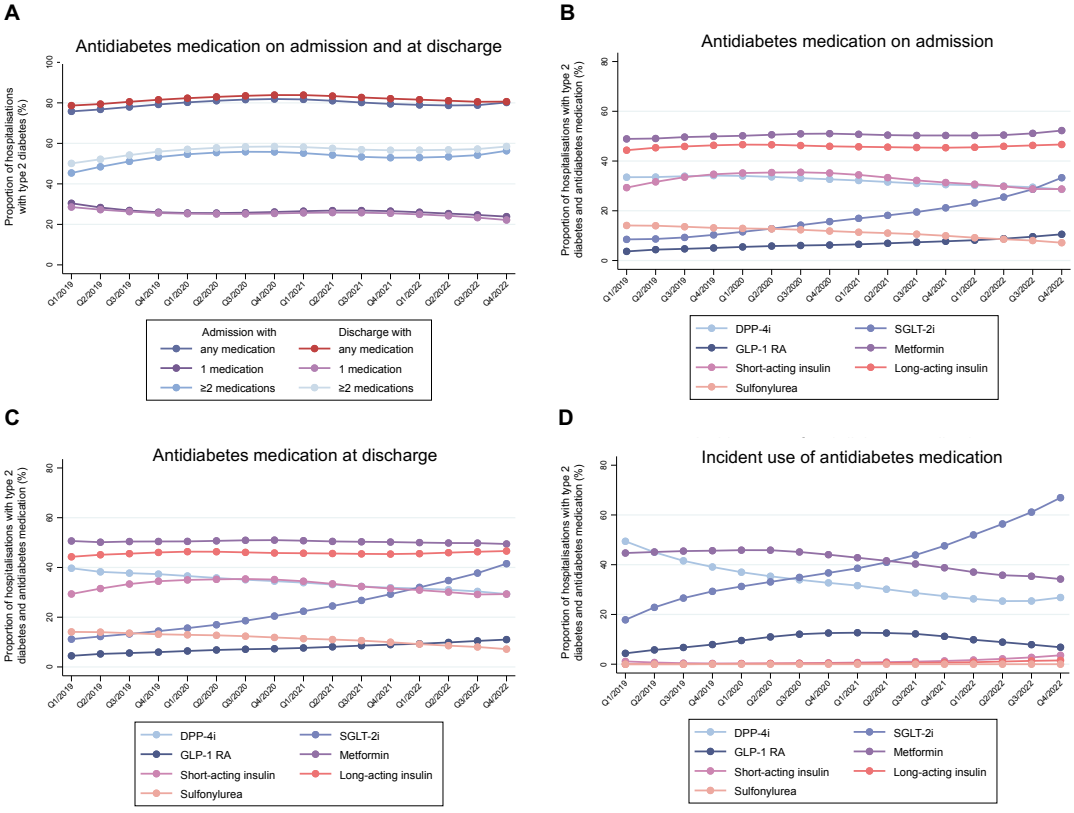

Figure 1 – Trends in antidiabetes medication use on admission and at discharge by quarters between 2019 and 2022
Proportion of hospitalisations with type 2 diabetes with any, 1 or ≥2 antidiabetes medications by quarter (A). Proportions of hospitalisations with type 2 diabetes using antidiabetes medications on hospital admission and at discharge (B-C) and those who are incident users (D) were analyzed quarterly.
Abbreviations: GLP-1 RA, glucagon-like peptide-1 receptor agonist; DPP-4, dipeptidyl peptidase-4; SGLT-2, sodium–glucose cotransporter-2

Figure 1 Trends in antidiabetes medication use on admission and at discharge by quarters between 2019 and 2022. Proportion of hospitalisations with type 2 diabetes with any, 1 or ≥2 antidiabetes medications by quarter (A). Proportions of hospitalisations with type 2 diabetes using antidiabetes medications on hospital admission and at discharge (B–C) and those who are incident users (D) were analysed quarterly. DPP-4i, dipeptidyl peptidase-4 inhibitors; GLP-1 RA, glucagon-like peptide-1 receptor agonist; SGLT-2i, sodium-glucose cotransporter-2 inhibitors.

respectively) (table 2, figure 1B,C). While the utilisation patterns for metformin, short-acting and long-acting insulin remained relatively stable over time, there was a decline in the use of DPP-4i and an upward trend in the use of GLP-1 RA both on hospital admission and at the time of discharge (table 2, figure 1B,C). Online supplemental figure 2 illustrates the quarterly patterns in the utilisation of each specific class of antidiabetes medication.

Among incident users, SGLT-2i were the most frequently prescribed antidiabetes medication class with an increase from 26% in 2019 to 56.1% in 2022 (p for trend <0.01) (table 2, figure 1D). A decrease in use was observed for DPP-4i, while there were no relevant changes among the remaining antidiabetes medication classes. Online supplemental table 1 illustrates the yearly changes in the utilisation of antidiabetes medications.

Utilisation trends of antidiabetes medications between 2019 and 2022 in hospitalisations with and without cardiovascular disease

Among hospitalisations with CVD, long-acting insulin was the most used antidiabetes medication over the study period on admission and at discharge, except for the last quarter of 2022. During the last quarter of 2022, we observed a switch from long-acting insulin to metformin (on admission) and to metformin and SGLT-2i (at discharge) being the most frequently prescribed antidiabetes medication classes in hospitalisations with CVD (online supplemental figure 3A,C). The largest increase in use at timepoint of hospital admission was seen for SGLT-2i (from 7.1% in 2019 to 24.7% in 2022; p for trend <0.01), whereas the strongest decrease in use was observed for sulfonylureas (from 12.3% in 2019 to 6.5% in 2022; p<0.01). Trends at timepoint of hospital discharge were similar. Among incident users with CVD, SGLT-2i were the most frequently newly prescribed antidiabetes medication with an increase from 34.9% in 2019 to 68.8% in 2022 (p for trend <0.01) (online supplemental table 2, online supplemental figure 3E).

In contrast, among the cohort without CVD, metformin was the most frequently prescribed antidiabetes medication over the years. Notably, the most substantial surge in utilisation occurred among SGLT-2i, evident at hospital admission, discharge and among incident users (online supplemental figure 3B, D and F). Concurrently, new prescriptions of DPP-4i declined over time (online supplemental figure 3F). The quarterly patterns in the use of each individual antidiabetes medication class among hospitalisations with and without CVD are shown in online supplemental figure 4.

Utilisation trends of antidiabetes medications between 2019 and 2022 in hospitalisations with and without chronic kidney disease

Among hospitalisations with CKD, long-acting insulin was the most frequently used antidiabetes medication, both on admission and at discharge. The largest increase in use was seen within the group of SGLT-2i from 4.4% in 2019 to 22% in 2022 (p for trend <0.01) on hospital admission and at discharge (online supplemental table 3 and online supplemental figure 5A, C). Among the incident users with CKD, we observed an almost linear increase in the use of SGLT-2i over time, while the use of DPP-4i continuously decreased (online supplemental figure 5E).

In contrast, among hospitalisations without CKD, the most frequently used antidiabetes medication over time was metformin, on admission and at discharge. The largest increase in use was observed within the group of SGLT-2i on hospital admission, at discharge and among incident users (online supplemental figure 5B, D and F). The quarterly patterns in the use of each individual antidiabetes medication class among patients with and without CKD are shown in online supplemental figure 6.

Utilisation trends of antidiabetes medications between hospital admission and discharge

We observed an increase of 2.3% in the proportion of hospitalisations receiving any class of antidiabetes medication at hospital discharge compared with the timepoint of hospital admission (p<0.01). This difference was even more pronounced in hospitalisations using two or more medications (+3.1%; p<0.01) (figure 2A, online supplemental table 4). In general, there was no evidence of deprescribing during hospitalisation.

Between hospital admission and discharge, we observed an increase in use of GLP-1 RA, SGLT-2i and DPP-4i (difference in proportion +0.9% for GLP-1 RA, +5.1% for SGLT-2i; +1.8% for DPP-4i; p<0.01, respectively) (figure 2B–D, online supplemental table 4), while there were no significant changes in the use of metformin, sulfonylurea, short-acting and long-acting insulin (figure 2E–H, online supplemental table 4). Within the group of SGLT-2i users, differences between admission and discharge remained significant over the entire study period (online supplemental table 5). When stratifying for individuals with CVD and CKD, findings remained robust (online supplemental tables 6–9).

Predictors for incident use and deprescribing of individual anti-diabetes medication classes during hospitalisation

Figure 3 illustrates predictors for the incident use or deprescription of the four antidiabetes medication classes with the largest change in use during hospitalisation (ie, metformin, DPP-4i, GLP-1 RA and SGLT-2i). Metformin deprescription was more common in patients with heart failure (risk ratio (RR) 1.75 (95% CI 1.23 to 2.49)), CKD (RR 1.3 (95% CI 1.02 to 1.67)) or liver diseases (RR 1.79 (95% CI 1.16 to 2.75)) (figure 3A). Incident use of DPP-4i during hospitalisation was associated with age ≥70 years (RR 2.03 (95% CI 1.39 to 2.97)) and CKD (RR 2.03 (95% CI 1.42 to 2.91)), but less likely in obese hospitalisations (RR 0.3 (95% CI 0.14 to 0.67)) (figure 3B). For GLP-1 RA, obese hospitalisations were more likely to receive a new prescription (RR 3.01 (95% CI 1.55 to 5.85)), while

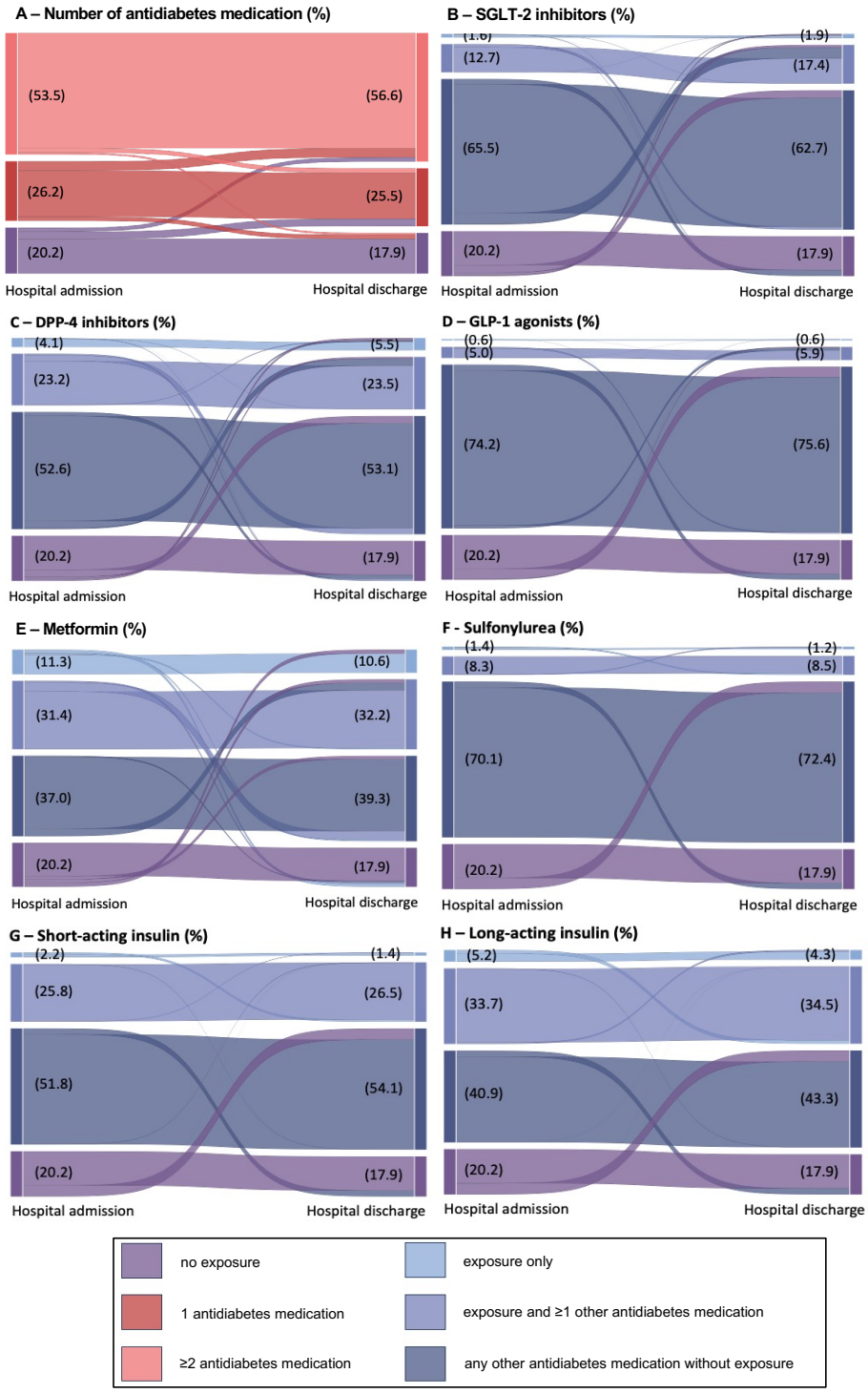

Figure 2 – Longitudinal patterns in use of antidiabetes medication classes among hospitalisations with type 2 diabetes from admission to discharge

The bars represent the proportions (%) of hospitalisations with type 2 diabetes with or without a certain number of antidiabetes medication (A) or an exposure to a specific antidiabetes medication class (B-H) on hospital admission (left) and hospital discharge (right).

Abbreviations: GLP-1 RA, glucagon-like peptide-1 receptor agonist; DPP-4, dipeptidyl peptidase-4; SGLT-2, sodium–glucose cotransporter-2

Figure 2 Longitudinal patterns in use of antidiabetes medication classes among patients with type 2 diabetes from admission to discharge. The bars represent the proportions (%) of hospitalisations with type 2 diabetes with or without a certain number of antidiabetes medication (A) or an exposure to a specific antidiabetes medication class (B–H) on hospital admission (left) and hospital discharge (right). DPP-4, dipeptidyl peptidase-4; GLP-1 RA, glucagon-like peptide-1 receptor agonist; SGLT-2, sodium-glucose cotransporter-2.

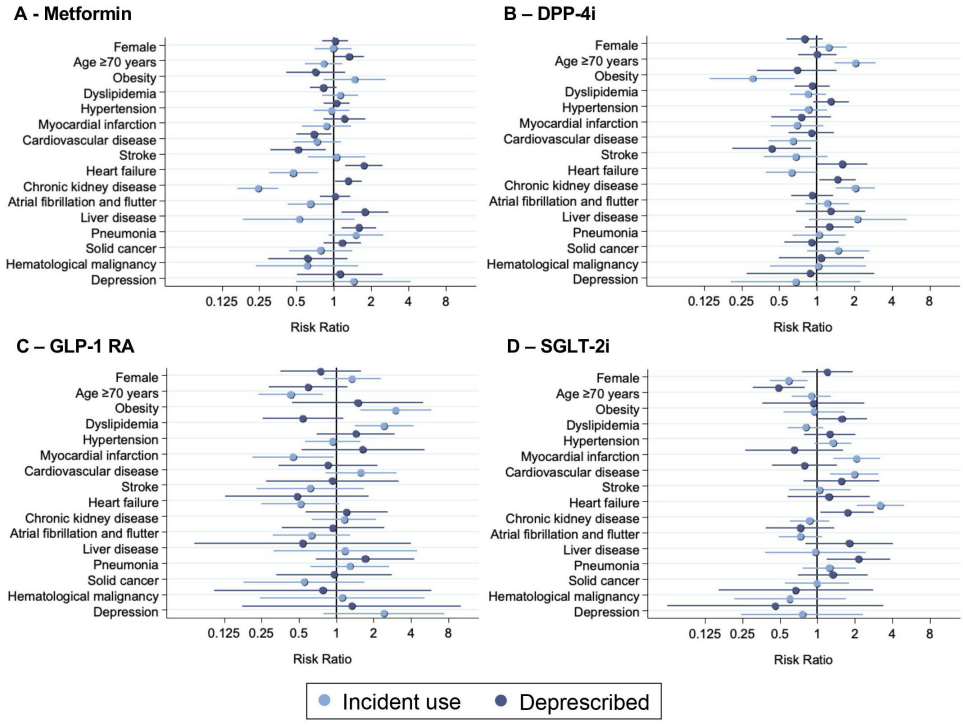

Figure 3 Predictors influencing the utilisation of different antidiabetes medication classes. Predictors for the incident use or the deprescription of the four antidiabetes medication classes with the largest usage changes during hospitalisation (ie, metformin, DPP-4i, GLP-1 RA and SGLT-2i). DPP-4i, dipeptidyl peptidase-4 inhibitors; GLP-1 RA, glucagon-like peptide-1 receptor agonist; SGLT-2i, sodium-glucose cotransporter-2 inhibitors.

those aged ≥70 years were less likely (RR 0.43 (95% CI 0.24 to 0.78)) (figure 3C).

SGLT-2i were deprescribed less frequently in hospitalisations aged ≥70 years (RR 0.49 (95% CI 0.3 to 0.79)) and initiated more frequently in those with CVD (RR 1.98 (95% CI 1.26 to 3.1)), including heart failure (RR 3.2 (95% CI 2.07 to 4.94)) (figure 3D).

DISCUSSION

The results of this observational study offer insights into the temporal trends and usage patterns of antidiabetes medications in adults with T2D hospitalised at a tertiary care facility in Switzerland. Between 2019 and 2022, approximately 80% of hospitalisations with T2D received any antidiabetes medication, while 50%–60% received two or more medications, showing a slight increase over the years. Notably, both prevalent and incident users exhibited a significant increase in SGLT-2i use and a decline in sulfonylurea use over the study period. No evidence of deprescribing was observed during hospitalisation, with SGLT-2i being the most frequently prescribed class of antidiabetes medication. The primary predictor for SGLT-2i prescription during hospitalisation was the presence of CVD, primarily driven by a diagnosis of heart failure.

Our observation of a higher SGLT-2i use and a lower sulfonylurea utilisation is likely linked to emerging evidence demonstrating cardiovascular and renal benefits of SGLT-2i.[9–17] Additionally, a meta-analysis of sulfonylurea trials revealed a higher incidence of hypoglycaemia and weight gain associated with this class.[18] The updated guidelines of the Swiss Society of Endocrinology and Diabetology also recommend first-line therapy with metformin in an early combination with an antidiabetes medication with proven cardiovascular benefit, such as SGLT-2i or GLP-1 RA,[19] aligning with insights from these studies.

While the Swiss drug administration (Swissmedic) approved the use of SGLT-2i for T2D in 2014, indications for heart failure were approved in 2020 (dapagliflozin) and 2021 (empagliflozin), and for CKD in 2021 (dapagliflozin). Correspondingly, we observed a pronounced increase in SGLT-2i use among hospitalisations with CVD or CKD following approvals for these indications suggesting that clinicians are incorporating the latest evidence into their clinical practice.

While data on trends in the use of antidiabetes medications among hospitalised patients are widely missing, our findings align with outpatient data from other countries, including the UK,[20 21] Denmark,[22] Canada,[20 23] the USA[24 25] and Australia,[20 26] all of which have reported a growing utilisation of SGLT-2i over time. However, it is worth noting that, unlike our study, these investigations do not specifically provide data on the trends in antidiabetes medication usage among hospitalised patients. In Switzerland, no similar data are available to date.

Given the high median age among our study population, benefits of a stringent glycaemic control may be diminished and associated harms of antidiabetes treatment rise.

Several observational studies, including older patients with T2D, link tight glycaemic control to increased risk of falls, hypoglycaemia, emergency department visits, hospitalisations and mortality.[27–29] Acknowledging this, the ADA's 'Standards of Medical Care in Diabetes' recommends deintensifying complex treatment regimes in older adults to mitigate polypharmacy and hypoglycaemia.[30] A recent review suggests considering deintensification of antidiabetes treatment, particularly in those with short life expectancy, low functional or cognitive status, severe or numerous comorbidities or prolonged diabetes duration.[31] Despite our predominantly older patient cohort, around 80% received antidiabetes medication, yet we observed no discernible deprescribing during hospitalisation or over the study period. Potential reasons might include clinician reluctance to deprescribe, especially in inpatient settings, unless complications or medication side effects are evident. Notably and in accordance with the current literature,[32] the use of high-risk hypoglycaemic agents like sulfonylureas decreased over the years, and they were no more initiated during hospitalisation. Nevertheless, all our findings must be interpreted prudently since we were not able to identify the reasons for (de-)prescribing.

In Switzerland, health insurance limitations dictated by Swissmedic approvals and manufacturer cost negotiations affect medication access. SGLT-2i are covered by mandatory health insurance when lifestyle changes fail to control glycaemia adequately. GLP-1 RA additionally require a minimum BMI of 28 kg/m^2 for coverage. These criteria align with international and national guidelines, ensuring minimal cost-related restrictions due to a 10% co-payment for non-generic medications. This low co-payment is not onerous compared with other countries, such as the USA. This lower financial hurdle could lead to more frequent prescriptions of new and more expensive antidiabetic medications like SGLT-2i and GLP-1 RA in Switzerland compared with other countries with higher out-of-pocket costs. While supply chain disruptions have impacted the availability of newer medications, particularly GLP-1 RA, their effect is mitigated by their predominant prescription in the outpatient setting, suggesting minimal influence on the observed prescribing trends in our study. Therefore, we think that these disruptions should not have significantly impacted the prescribing patterns of antidiabetes medications, nor the trends observed in our study.

During the COVID-19 pandemic, affecting the first part of our study period, healthcare systems experienced significant disruptions, which likely influenced the trends in antidiabetes medication management observed from 2019 to 2022. Although this analysis relies on data from hospitalisations only, the prioritisation of medications that require less frequent monitoring, such as SGLT-2i, might have been driven by the need to reduce patient exposure to COVID-19 and adapt to the rise of telehealth. Additionally, the increased risk of COVID-19 complications in individuals with diabetes may have prompted more aggressive management strategies, particularly favouring medications with cardiovascular and renal benefits. Changes in hospital admission patterns and disruptions in medication supply chains could also have contributed to the shifts in prescribing practices during the pandemic. Variations in patient access to healthcare due to economic reasons might be possible but unlikely to have relevantly influenced any prescribing trends in Switzerland.

A main strength of our study lies in the up-to-date study cohort, extending until the end of 2022. Moreover, it represents one of the few investigations on prescription trends of antidiabetes medications in the inpatient setting, both in Switzerland and globally.

This study also has limitations. First, external validity is constrained by its single-centre cohort design. Second, the absence of clinical information and laboratory values, along with unknown reasons for (de-)prescribing, further limits the conclusion of this study. Thus, it remains unclear whether a medication was deprescribed following clinical guidelines among older people or in response to any adverse drug events. Third, our analysis was confined to in-hospital data, and therefore, does not extend to outpatients. Consequently, our findings only pertain to patients who were sick enough to be hospitalised and whose underlying health conditions probably predisposed them to treatment with SGLT-2i, such as patients with heart and/or renal failure or patients with obesity in relation to GLP-1 RA. However, based on existing evidence regarding the efficacy of SGLT-2i and GLP-1 RA, significant deviations from our findings appear unlikely. Fourth, even though our 'incident cohort' included individuals who had not filled any antidiabetes medication prescriptions on hospital admission, there remains a possibility that certain 'incident users' may not have been initiating the antidiabetes treatment of interest for the first time. Finally, given the origin of data, underreporting of ICD-10-based diagnoses due to coding issues must be considered.

Conclusion

In conclusion, this observational study explored trends in antidiabetes medication utilisation among medical hospitalisations with T2D. Our real-world data show a relevant shift in the use of antidiabetes medications from 2019 to 2022 in the in-hospital setting with a constant decrease in the use of sulfonylureas and a strong increase in prescription of SGLT-2i, particularly among hospitalisations with CVD or CKD. These prescribing trends were in line with recent recommendations from international societies and suggest the early adaption of recommendations by healthcare providers. These findings contribute to a better understanding of how medical inpatient gets treated with antidiabetes medications, offering a perspective on diabetes management in a complex patient population.

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