# Admission Rates and Care Pathways in Patients with Atrial Fibrillation during the COVID-19 Pandemic – Insights from the German-wide Helios Hospital Network

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**Conflict of interest:**

Gerhard Hindricks is receiving grants through the Leipzig Heart Institute from Boston Scientific

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**Abstract**

Introduction: Several reports indicate lower rates of emergency admissions in the cardiovascular sector and reduced admissions of patients with chronic diseases during the COVID-19 pandemic. The aim of this study was therefore to evaluate numbers of admissions in incident and prevalent atrial fibrillation and flutter (AF) and to analyze care pathways in comparison to 2019.

Methods: A retrospective analysis of claims data of 74 German Helios hospitals was performed to identify consecutive patients hospitalized with a main discharge diagnosis of AF. A study period including the start of the German national protection phase (13th March 2020 to 16th July 2020 ) was compared to a previous year control cohort (15th March 2019 to 18th July 2019), with further sub-division into early and late phase. Incidence rate ratios (IRR) were calculated. Numbers of admission per day (A/day) for incident and prevalent AF and care pathways including readmissions, numbers of transesophageal echocardiogram (TEE), electrical cardioversion (CV) and catheter ablation (CA) were analyzed.

Results:

During the COVID-19 pandemic, there was a significant decrease of total AF admissions both in the early (44.4 vs. 77.5 A/day, IRR 0.57 [95% CI 0.54 – 0.61], p<0.01) and late phase (59.1 vs. 63.5 A/day, IRR 0.93 [95% CI 0.90 – 0.96], p<0.01), length of stay was significantly shorter (3.3 ±3.1 nigths vs. 3.5 ±3.6 nigths, p<0.01), admissions were more frequently in high volume centers (77.0% vs. 75.4%, p=0.02) and frequency of readmissions was reduced (21.7% vs. 23.6%, p<0.01) compared to the previous year.

Incident AF admission rates were significantly lower both in the early (21.9 admission per day versus 41.1 A/day, IRR 0.53 [95% CI 0.48−0.58]) and late phase (35.5 vs. 39.3 A/day, IRR 0.90 [95% CI 0.86−0.95]), whereas prevalent admissions were only lower in the early phase (22.5 vs 36.4 A/day IRR 0.62 [95% CI 0.56−0.68]), but not in the late phase (23.6 vs. 24.2 A/day IRR 0.97 [95% CI 0.92−1.03]).

Analysis of care pathways showed reduced numbers of TEE during the early phase (34.7% vs. 41.4%, OR 0.74 [95% CI 0.64−0.86], p<0.01), but not during the late phase (39.9% vs. 40.2%, OR 0.96 [95% CI 0.88−1.03], p=0.26). Numbers of CV were comparable during early (40.6% vs. 39.7%, OR 1.08 [95% CI 0.94−1.25], p=0.27) and late phase (38.6% vs. 37.5%, OR 1.06 [95% CI 0.98−1.14], p=0.17), compared to the previous year, respectively. Numbers of CA were comparable during the early phase (21.6% vs. 21.1%, OR 0.98 [95% CI 0.82−1.17], p=0.82) with a distinct increase during the late phase (22.9% vs. 21.5%, OR 1.05 [95% CI 0.96 – 1.16], p=0.28).

Conclusion:

During the COVID-19 pandemic, AF admission rates declined significantly, with a more pronounced reduction in incident than in prevalent AF. Overall AF care was maintained during early and late pandemic phase with only minor changes, namely less frequent use of TEE. Confirmation of these findings in other study populations as well as identification of underlying causes are required to ensure optimal therapy in patients with AF during the COVID-19 pandemic.

**Abbreviations**

| | |
|---|---|
| AF | atrial fibrillation and atrial flutter |
| CA | catheter ablation |
| CCI | Charlson comorbidity index |
| COVID-19 | Coronavirus SARS-CoV-2 |
| CumHD | cumulative hospitalization deficit |
| CV | electrical cardioversion |
| IRR | incidence rate ratios |
| TEE | transesophageal echocardiogram |

## Introduction

The Coronavirus SARS-CoV-2 **(**COVID-19) pandemic implies two major challenges for the healthcare systems worldwide: conception of adequate medical care pathways for the COVID-19 diseased and maintenance of usual medical care for patients without COVID-19. In the cardiovascular sector, several reports indicated lower rates of emergency admissions during the national lockdowns[1-3] and admissions of patients with chronic diseases were reported to be reduced as well[4-6]. Besides worries about delayed care in emergency situations, the decrease in admission rates may be also accompanied by underdiagnosis of relevant cardiac diseases causing only moderate to mild symptoms. For atrial fibrillation or atrial flutter (AF), a 47% lower incidence of patients with new-onset AF was reported in comparison to 2019 in a Danish nationwide registry[7]. The aim of this study was therefore to evaluate number of admissions in incident and prevalent AF and to analyze care pathways during the COVID-19 pandemic in comparison to the previous year in 74 Helios hospitals in Germany.

## Methods

### Data collection

We retrospectively analyzed claims data of 74 German hospitals for consecutive patients hospitalized in- or outpatients with a main discharge diagnosis of AF (ICD code I48, contains paroxysmal, persistent and permanent atrial fibrillation, typical and atypical atrial flutter) using information on diagnoses coded via the International Statistical Classification of Diseases and Related Health Problems (ICD-10-GM [German Modification]) and procedures coded via the Operations and Procedures codes (OPS, German adaption of the International Classification of Procedures in Medicine of the World Health Organization, version 2020) as previously described[8]. Administrative data were extracted from QlikView (QlikTech, Radnor, Pennsylvania, USA). Cases with lab-confirmed COVID-19 infection (ICD code U07.1) were excluded. Data were stored pseudonymized and data use was approved by the Helios Kliniken GmbH data protection authority.

Study cohorts

Based on admission dates, a study period from 13th March 2020 to 16th July 2020 including the start of the German national protection phase and a previous year control cohort from 15th March 2019 to 18th July 2019 were analyzed (numerical date shift due to coherent weekdays and leap year considerations). Study and control periods were further divided into early and late phase, determined by the nadir in admissions as the lowest point of the 2020 admissions modelised using a locally estimated scatterplot smoothing approach. We used the early and late phase subdivision to evaluate initial effects following lockdown announcement and adaptation mechanisms, respectively and chose the nadir week in the light of suspected minimal coping capacities in the hospitals. Thus, the early phase is defined from 13th March 2020 – 11th April 2020 and 15th March 2019 – 13th April 2019 and the late phase from 12th April 2020 – 16th July 2020 and 14th April 2019 – 18th July 2019. Evaluating hospitalization deficits, we used the nadir week from 3rd April – 9th April 2020, defined as the week with the lowest admission numbers following national lockdown, for further analysis. Admissions were classified as urgent and non-urgent. Urgent admission presented via the emergency department and were patient-initiated, initiated by the local Cardiologist or General practitioner or referrals from other clinics. Charlson comorbidity index (CCI) and $CHA_2DS_2$-VASc score were calculated with minor adjustments according to previous publications[8, 9].

Incident and prevalent AF

Incident and prevalent AF was defined based on pre-existent AF diagnosis: patients without admission for atrial fibrillation (I48) as main or secondary diagnosis the 3 years prior to the starting date of the cohort were considered as presenting with incident, patients with a documented diagnosis of AF in the previous three years prevalent AF. Of note, it was possible that the same patient appears in both the two cohorts, or be admitted first for incident and then for prevalent AF.

Care pathways

Admission type was classified as urgent or non-urgent. Non-urgent admissions were scheduled before or at the early phase of the COVID-19 pandemic. Length of stay was defined as number of nights during hospital stay. Readmissions were calculated within each analyzed time period separately. The following AF-related procedures were analyzed based on OPS codes (in parentheses): transesophageal echocardiogram (TEE, 3-052), cardioversion (CV, 8-640) and catheter ablation (CA, 8-835). Hospital volume was categorized according to first admission numbers per hospital during the baseline control period and computed as tertiles. Low-, intermediate- and high-volume hospitals were thus defined as ≤ 267, 268−590 and > 590 admissions.

Statistical analysis

Incidence rates for AF admissions (admission per day [A/day]) were calculated by dividing the number of cumulative admissions by the number of days for each time period. Incidence-rate ratios (IRR) comparing the study period to each of the control periods or the early study period to the late study period were calculated using Poisson regression to model the number of hospitalizations per day. Number of admissions were calcuated for all combinations of (a) factor levels (i.e, age, sex, etc.), (b) hospitals, and (c) admission dates (of the corresponding period). These frequencies were used to create the dependent variables of the statistical models.

The cumulative hospitalization deficit (CumHD) was computed as follows: difference between the expected and observed cumulative admission number for every week in the study period, expressed as a percentage (95% CI) of the cumulative expected number. The expected admission number was defined as the weekly average during the control period. The difference between the expected and observed cumulative admission number was assessed using a $\chi$ 2 test for the admission nadir defined as the week with the lowest admission number (3rd April - 9th April 2020) and the last week of the study period (10th July - 16th July 2020)[10].

Inferential statistics were based on generalized linear mixed models (GLMM) specifying hospitals as random factor[11, 12]. We employed Poisson GLMMs with log link function for count data. Effects were estimated with the lme4 package (version 1.1-21)[13] in the R environment for statistical computing (version 3.6.1, 64-bit build) (R Core Team 2019). In all models, we specified varying intercepts for the random factor. The IRR values for the different factor levels are based on the different models comparing the periods, respectively. Additionally, we employed another model for each factor with the variables (a) period, (b) treatment contrasts for the factor levels (for comparisons with the baseline level), and (c) the corresponding interactions. We report incidence-rate ratios (calculated by exponentiation of the negative of the regression coefficients) together with 95% confidence intervals (for the comparisons of the two periods) and *p* values for the interactions. For all tests we apply a two-tailed 5% error criterion for significance.

For the comparison of proportions of selected treatments, we used logistic GLMMs with logit link function. We report proportions, odds ratios (OR) together with 95% confidence intervals (95% CI) and *p* values. The analysis of age and the outcome variable length of stay was performed via linear mixed models, where we report means, standard deviations (SD), regression coefficients (RC), 95% CI and *p* values. RCs correspond to the change in the dependent variable between the study period and one of the control periods. For linear mixed models, the computation of *p* values was done via the Satterthwaite approximation. For the description of the cohorts (comparison of the proportion of the factor variables of interest), we specified logistic generalized linear models with one model per factor level; we report proportions and *p* values.

**Results**

The study cohort consisted of 7,001 and the control cohort of 8,424 patient cases (Figure 1, Table 1).

Patients in the study cohort were more likely to have congestive heart failure (29.8% vs. 28,3%, p=0.04, Suppl. material Table 1.) and less likely to have metastatic solid tumor (0.1% vs. 0.2%, p=0.03). $CHA_2DS_2$-VASc score composition differed with a higher frequency of high values ($CHA_2DS_2$-VASc score ≥ 5, 18.3% vs. 16.2%, p<0.01) and lower frequency of intermediate values ($CHA_2DS_2$-VASc score 2-4, 58.8% vs. 61.6%, p<0.01) during the study phase, compared to the control period. On the contrary, no significant differences were present in values of CCI during study and control period (Table 1).

AF admissions during the pandemic

There was a significant decrease of total AF admissions both in the early (44.4 vs. 77.5 A/day, IRR 0.57 [95% CI 0.54 – 0.61], p<0.01) and late phase (59.1 vs. 63.5 A/day, IRR 0.93 [95% CI 0.90 – 0.96], p<0.01, Figure 1). The CumHD was -31% until the nadir week (3rd April – 9th April 2020) and -17% until the final week of the study period (10th July – 16th July 2020) in total AF admissions (Figure 2, Table 2, Suppl. Figure 1).

Incident and prevalent AF

The proportion of incident AF tended to be lower in the study compared to the control period (58.0% vs. 59.4%, p=0.08). Both in the early and late phase, incident AF IRRs were more pronounced reduced than prevalent AF IRRs (early phase: 0.53 in incident AF [95% CI 0.48−0.58] vs. 0.62 in prevalent AF [95% CI 0.56−0.68], late phase 0.90 in incident AF [95% CI 0.86−0.95] vs. 0.97 in prevalent AF [95% CI 0.92−1.03], respectively, Figure 2). Concerning clinical characteristics, patients with incident AF were younger (69.5 ±12.1 vs. 71.1 ±11.2, <0.01) and were more likely to have a lower CCI of 0-1 (70.4% vs. 65.5%, p<0.01) and less likely to have CCIs of 2-4 (25.5% vs. 28.7%, p<0.01) and ≥ 5 (4.1% vs. 5.7%, p<0.01) with similar findings in $CHA_2DS_2$-VASc score compared to patients with prevalent AF.

Care pathways during the pandemic

Length of stay was significantly shorter during the study compared to the control period (3.3 ±3.1 nights vs. 3.5 ±3.6 nights, RC -0.23 (95% CI -0.35−-0.11), p<0.01), based mainly on shorter length of stay during the late phase. Urgent admissions were more frequent (51.2% vs. 48.3%, p<0.01) during the study phase compared to 2019. Patients with AF were re-hospitalized less frequently during 2020 (number of admission more than one in 21.7% vs. 23.6% of cases, p<0.01) compared to the control period. When hospitalized, patients with AF were more often in high volume centers (77.0% vs. 75.4%, p=0.02) and less often in low volume centers (2.2% vs. 3.0%, p<0.01, Table 1).

The overall proportion of patients receiving TEE was significantly lower during the study period, compared to the control period (38.9% vs. 40.5%, p=0.04). Of note, use of TEE was only reduced during the early phase (34.7% vs. 41.4%, OR 0.74 [95% CI 0.64−0.86], p<0.01) but not during the late phase (39.9% vs. 40.2%, OR 0.96 [95% CI 0.88−1.03], p=0.26) when compared to the previous year.

There was no difference in proportion of patients undergoing CV during study compared to control period both during early early (40.6% vs. 39.7%, OR 1.08 [95% CI 0.94−1.25], p=0.27) and late phase (38.6% vs. 37.5%, OR 1.06 [95% CI 0.98−1.14], p=0.17) analyzing all AF patients. However, in patients with prevalent AF, CV was more frequently performed during the early study phase compared to the last year (42.4% vs. 38.2%, p=0.04).

There was a trend towards more catheter ablations in admitted AF patients during the study period (22.7% vs. 21.4%, p=0.05) compared to the control period. Notably, during the early phase, the proportion of patients undergoing catheter ablation was similar to the year before (21.6% vs. 21.1%, OR 0.98 [95% CI 0.82−1.17], p=0.82). During the late phase, however, there was a distinct but non-significant increase in proportion of patients undergoing catheter ablations (22.9% vs. 21.5%, OR 1.05 [95% CI 0.96 – 1.16], p=0.28).

Of note, absolute numbers of all procedures were reduced both in the early as well as in the late phase of the study period compared to the previous year (TEE: 462 vs. 964, CV: 540 vs. 924, CA 288 vs. 491 during early phase, TEE: 2,262 vs. 2,450, CV: 2,188 vs. 2,286, CA: 1,299 vs. 1,309).

**Discussion**

During the COVID-19 pandemic, there was a significant decrease of admissions with main diagnosis AF compared to the previous year in 72 Helios hospitals in Germany.

This is in line with a previous study by Holt and colleagues, reporting a 47% decline of incident AF admissions during three weeks of national lockdown in Denmark compared to 2019[7]. Of note, we were able to show that this was more pronounced during the early phase of the COVID-19 pandemic, the time including announcement of national lockdown and sanctions in very quick successions, and less accentuated during the late phase in April to July 2020.

In contrast to the study by Holt and colleagues, we were also able to compare rates of incident and prevalent AF and showed that in particular hospital admissions of patients with incident AF were more reduced (Table 2). Interestingly, Holt and colleagues reported a 47% drop in total numbers of new-onset AF incidence[7] and our analysis confirmed an IRR of 0.53 (95% CI 0.48−0.58) during the early phase in incident AF.

Patients admitted during the COVID-19 pandemic had more frequently congestive heart failure, in line with the Danish study[7], but had in contrast less often metastatic solid tumor, although absolute numbers were very small.

There were three possible explanations suggested concerning the decline in incident AF: 1) lower frequency of routine or screening contacts, 2) postponed follow-up visits in patients with suspected AF and 3) truly lower incidence during massive societal turning points[7]. The third point, however, has to be questioned, as the numbers of prevalent AF did almost reach the value of the previous year in the late phase of our study (prevalent AF during late study phase 23.6 A/day and during late control phase 24.2 A/day, IRR 0.97 [95% CI 0.92−1.03]. It is therefore unlikely, that true incidence but not true prevalence decreases during pandemic circumstances. We therefore evaluated a fourth possible explanation taking into account the typical AF onset age. It is known that AF incidence is markedly increased after the age of 50 years in men and 60 years in women[14]. During the COVID-19 pandemic, this is the generation with serious fear of infection and loss of job, with diminished coping tools in the second half of life. Facing existential fear, it may be more likely that mild to moderate symptoms assume subordinated. Nevertheless, comparison of age distribution in incident AF admissions during the pandemic year compared to the previous year showed that there was no significant difference in mean age or the three age categories ≤ 64 years, 65−74 years and ≥ 75 years. We therefore suggest 1) or 2) as the underlying causes of the decline in incident AF admission, although confirmation of these findings in other study populations is necessary.

For cardiovascular disease, the use of telemedicine is promoted as a possibility to maintain usual care and ensure timely contact to the patient without infectious risk[15]. Peretto and colleagues described the setting of a multidisciplinary “myocarditis disease unit” for management of inpatient as well as outpatient visits[15]. Although unquestioned a timely concept, the problem of under-diagnosing due to reduced screening and therapy planning consultations has not been addressed yet.

Search engine queries for chest pain and home care for chest pain have risen during the pandemic[16] and simultaneously, lower admission rates for ST-elevation myocardial infarction have been reported. Whether gadgets and applications capable of diagnosing AF would be beneficial for patients with mild symptoms and high threshold for self presentation, needs to be evaluated in the future as well.

Our analysis showed a lower proportion of patients receiving TEE during the study period compared to the control period, exclusively driven by reduced TEE proportions during the early phase (34.7% vs. 41.4%, p<0.01). Of note, this could not be explained due to lower $CHA_2DS_2$-VASc scores in the study period.

It is possible, however, that this is explained by direct droplet transmission and viral aerosolization during the examination and thus higher risk for infections in general during execution of examination. In addition, special safety precautions were recommended by the expert associations[17, 18], altogether possibly leading to stricter indications.

Furthermore, CV was more frequently used in prevalent AF patients compared to controls, accompanied by higher rates of CAs, although absolute numbers of all procedures were lower during the study phase compared to the previous year. Simultaneously, readmission rates were lower compared to 2019 both in incident and prevalent AF. Whether these effects are due to the stronger attempts to reduce avoidable medical re-contacts and thus reduce the risk for infection needs to be evaluated further.

Interestingly, our analysis showed that during the late pandemic phase, numbers of CAs even exceeded numbers of the previous year with a slight but non-significantly increase of the proportion of patients undergoing CA. Of note, non-urgent admissions and procedures had to be postponed in Germany between March 16 and end of April, 2020 as part of the "protection" stage of the German pandemic plan. The increase may be the effect of a relaxing of regulations or of adaptations in the hospital, allowing to schedule elective patients safely and catch up on cancelled appointments. In addition, catheter ablations of highly symptomatic patients or patients with worse heart failure symptoms were not cancelled but only patients with moderate or light symptoms.

In general, absolute numbers of admissions increased during early and late phase in the 2020 study period (44.4 vs 59.1 admissions per day) whereas the 2019 cohort showed a decline from early to late phase (77.5 vs 63.5 admissions per day). Whether these differences can be explained with a decline of electively scheduled patients during summer holidays in 2019 (decline in late phase) and lower numbers of COVID-19 infections during summer and better adaptions of the hospitals for elective patients in summer 2020 (increase in late phase) is only speculative. In addition, length of stay was significantly shorter, a phenomenon already observed in acute coronary syndrome[2].

<u>Limitations</u>

The present study was based on claims data collected for reimbursement purposes. An intrinsic limitation of this approach is that results largely depend on quality of encoded diagnoses and procedures[19, 20]. Besides, detailed information about past medical history and comorbidities, physiognomy, referral status except for urgent or elective, results of diagnostic testing like imaging and lab values, medication including anticoagulation, compliance and treatment-related specific data were not available. In particular, information on prior outpatient treatments was not available and whether changes in admissions were related to a more effective management in the outpatient setting is unknown.

A COVID-19 pandemic specific limitation is that, although diagnosis of proven infection lead to exclusion, there may be a relevant number of undetected infections. In addition, although numbers of COVID-19 infections were counted for each federal state respectively (Suppl. Table 2), information about local restrictions was not available. It is very likely, that patients who were discharged received different advice for recurrence during the COVID-19 pandemic than the year before, adjusted to local and temporal infection trends. Concerning incident and prevalent AF, we were only able to identify patients as prevalent AF, if the pre-existent AF diagnosis (I48) was within one of the Helios hospitals. Thus, it is possible that the true number of incident AF admissions is even smaller, suggesting that a small proportion of patients was pre-diagnosed with AF in another institution. Of note, in this case incident AF admission rates would be even more reduced than in our current analysis. Furthermore, this analysis was based on administrative data of German Helios hospitals and our findings may not be generalizable to University or public hospitals other countries.

**Conclusion**

During the COVID-19 pandemic, AF admission rates declined significantly, with a more pronounced reduction in incident compared to prevalent AF. Despite the aforementioned changes in AF care pathways, it has to be concluded that overall AF care was maintained during early and late pandemic phase with only minor changes. On the contrary, the lack of AF admission rates, especially in incident AF, needs more attention and concern. Confirmation of these findings in other study populations as well as identification of underlying causes are required to ensure optimal therapy in patients with AF during the COVID-19 pandemic.

**Data Availability Statement**

The data underlying this article will be shared on reasonable request to the corresponding author.

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**Figure legend**

Figure 1. Description of study cohorts and numbers of AF admissions during early and late phase.

Figure 2.Number of AF patient cases (total, incident and prevalent) and admissions per week during study and control cohort.

**Table legend**

Table 1. Patient characteristics and characteristics of hospital stay of study (13th March 2020 to 16th July 2020 ) and control period (15th March 2019 to 18th July 2019).

Table 2. Cumulative hospitalization deficit (CumHD) during the nadir (3rd April – 9th April 2020) and the final week (10th July – 16th July 2020). The cumulative expected hospitalization is computed using the weekly average for the same period in 2019 as a baseline.

Table 3. Care pathways of patients admitted with AF during study (13th March 2020 to 16th July 2020 ) and control period (15th March 2019 to 18th July 2019).

**Figures**

Figure 1.

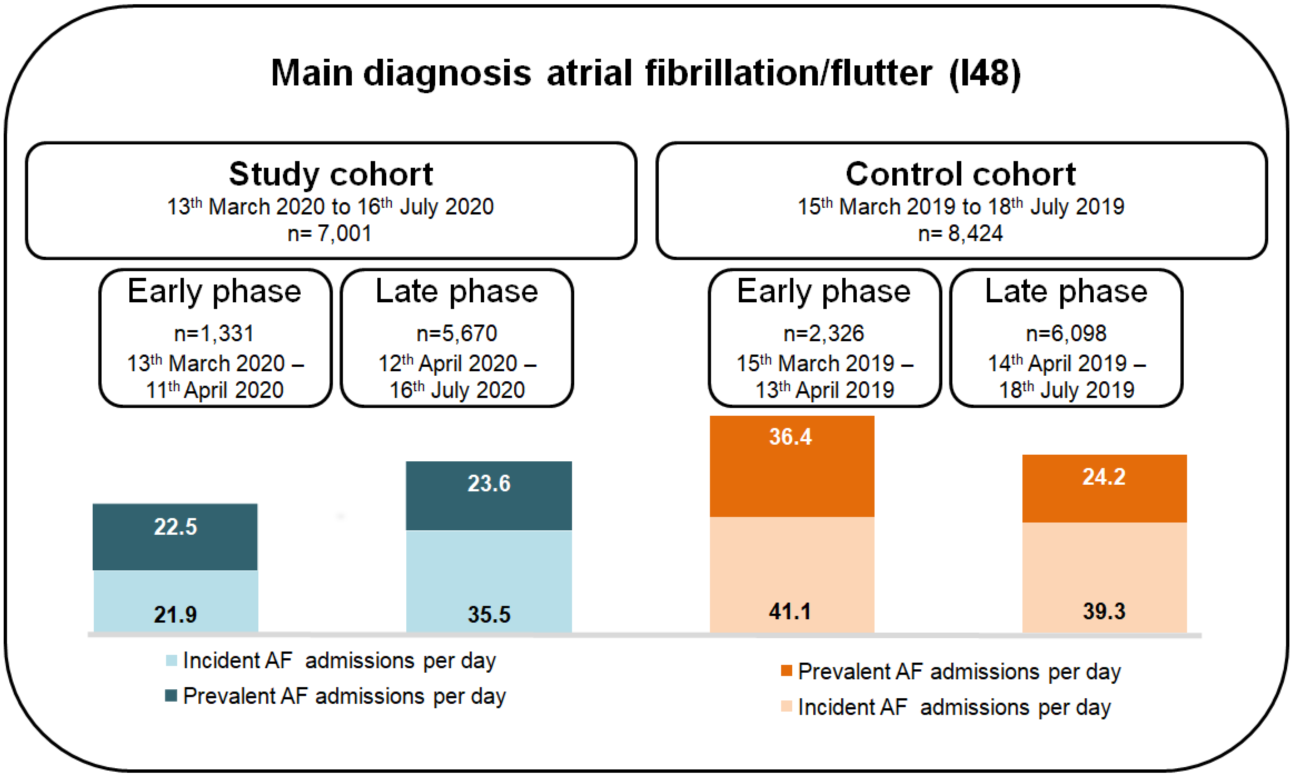
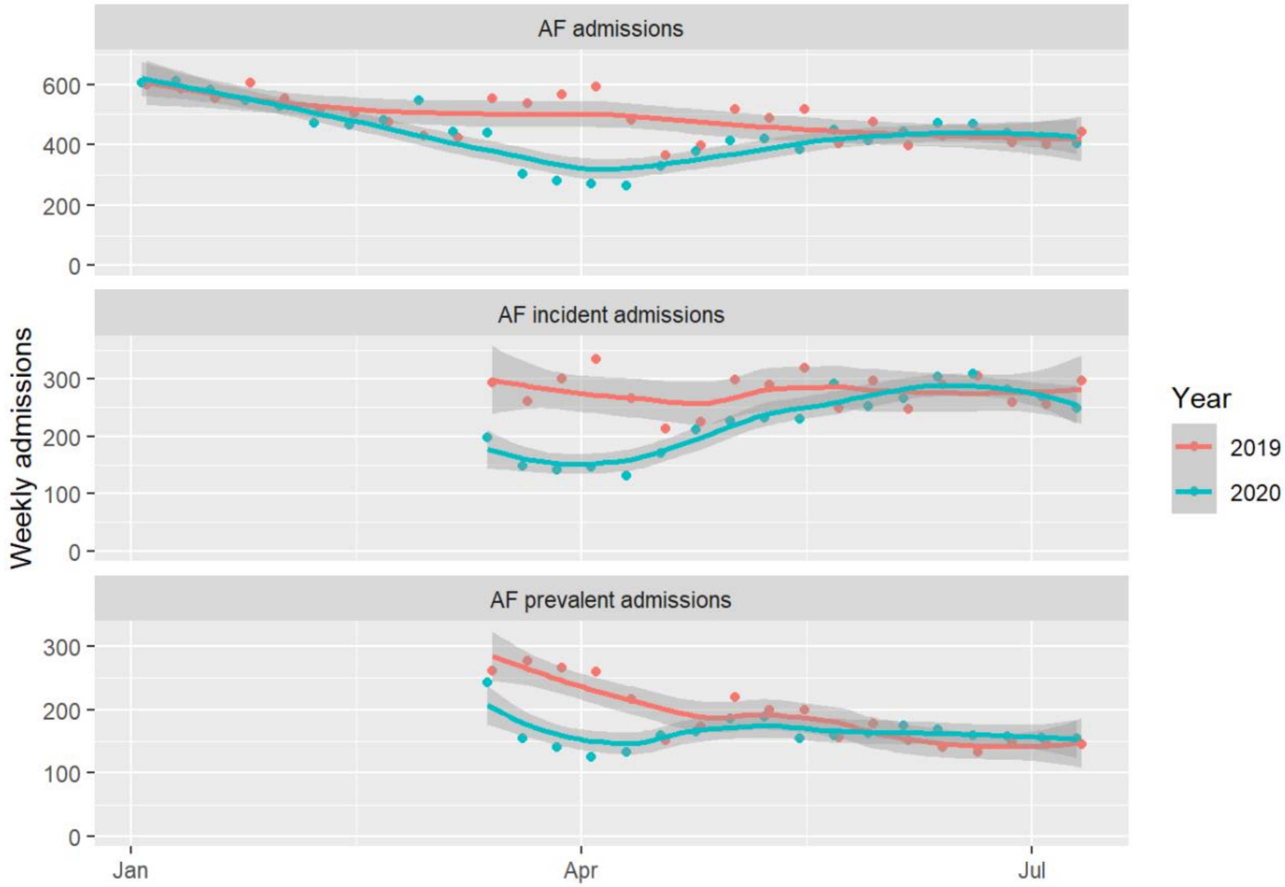


Figure 2.


AF admissions
600
400
200
0
AF incident admissions
300
200
100
0
AF prevalent admissions
300
200
100
0
Weekly admissions
Jan
Apr
Jul
Year
2019
2020

**Tables**

Table 1.

| | Study cohort, n=7,001 | Control cohort, n=8,424 | |
|---|---|---|---|
| | **Proportion (n) or mean (±) SD** | **Proportion (n) or mean (±) SD** | ***P* Value** |
| Age | | | |
| Age (years) | 70.3 ±11.7 | 70.1 ±11.8 | 0.16 |
| Sex | | | |
| Male | 53.7% (3,757) | 54.4% (4,580) | |
| Female | 46.3% (3,244) | 45.6% (3,844) | 0.38 |
| AF prevalent or incident | | | |
| Incident | 58.0% (4,060) | 59.4% (5,004) | |
| Prevalent | 42.0% (2,941) | 40.6% (3,420) | 0.08 |
| Charlson comorbidity index | | | |
| 0−1 | 68.9% (4,823) | 68.0% (5,728) | 0.23 |
| 2−4 | 26.5% (1,855) | 27.1% (2,280) | 0.43 |
| ≥ 5 | 4.6% (323) | 4.9% (416) | 0.35 |
| $CHA_2DS_2$-VASc-score | | | |
| 0−1 | 22.9% (1,605) | 22.2% (1,868) | 0.27 |
| 2−4 | 58.8% (4,118) | 61.6% (5,191) | < 0.01 |
| ≥ 5 | 18.3% (1,278) | 16.2% (1,365) | < 0.01 |
| Myocardial infarction | | | |
| No | 95.7% (6,700) | 95.8% (8,074) | |
| Yes | 4.3% (301) | 4.2% (350) | 0.66 |
| Congestive heart failure | | | |
| No | 70.2% (4,914) | 71.7% (6,042) | |
| Yes | 29.8% (2,087) | 28.3% (2,382) | 0.04 |
| Peripheral vascular disease | | | |
| No | 95.0% (6,649) | 94.6% (7,973) | |
| Yes | 5.0% (352) | 5.4% (451) | 0.36 |
| Cerebrovascular disease | | | |
| No | 97.8% (6,850) | 97.8% (8,242) | |
| Yes | 2.2% (151) | 2.2% (182) | 0.99 |
| Dementia | | | |
| No | 98.7% (6,907) | 98.5% (8,297) | |
| Yes | 1.3% (94) | 1.5% (127) | 0.39 |
| Chronic pulmonary Disease | | | |
| No | 94.0% (6,580) | 93.3% (7,860) | |
| Yes | 6.0% (421) | 6.7% (564) | 0.08 |
| Rheumatic Disease | | | |
| No | 98.9% (6,927) | 98.9% (8,333) | |
| Yes | 1.1% (74) | 1.1% (91) | 0.89 |
| Peptic ulcer disease | | | |
| No | 99.8% (6,989) | 99.8% (8,408) | |
| Yes | 0.2% (12) | 0.2% (16) | 0.79 |
| Mild liver disease | | | |
| No | 99.0% (6,932) | 99.1% (8,346) | |

| | | | |
|---|---|---|---|
| Yes | 1.0% (69) | 0.9% (78) | 0.70 |
| Diabetes | | | |
| No | 84.9% (5,942) | 83.8% (7,062) | |
| Yes | 15.1% (1,059) | 16.2% (1,362) | 0.08 |
| Hemiplegia or paraplegia | | | |
| No | 99.3% (6,954) | 99.2% (8,356) | |
| Yes | 0.7% (47) | 0.8% (68) | 0.33 |
| Chronic kidney disease | | | |
| No | 77.5% (5,429) | 77.0% (6,489) | |
| Yes | 22.5% (1,572) | 23.0% (1,935) | 0.45 |
| Any malignancy | | | |
| No | 99.3% (6,951) | 99.3% (8,366) | |
| Yes | 0.7% (50) | 0.7% (58) | 0.85 |
| Moderate or severe liver disease | | | |
| No | 100.0% (6,998) | 99.9% (8,412) | |
| Yes | 0.0% (3) | 0.1% (12) | 0.06 |
| Metastatic solid tumor | | | |
| No | 99.9% (6,995) | 99.8% (8,404) | |
| Yes | 0.1% (6) | 0.2% (20) | 0.03 |
| Number of admissions | | | |
| 1 | 78.3% (5,482) | 76.4% (6,436) | |
| > 1 | 21.7% (1,519) | 23.6% (1,988) | < 0.01 |
| Admission type[a] | | | |
| Regular | 48.8% (2,843) | 51.7% (3,626) | |
| Urgent | 51.2% (2,981) | 48.3% (3,390) | < 0.01 |
| Length of stay[b] | | | |
| Nights | 3.3 ±3.1 | 3.5 ±3.6 | < 0.01 |
| Hospital volume[c] | | | |
| Low | 2.2% (156) | 3.3% (280) | < 0.01 |
| Intermediate | 20.8% (1,454) | 21.2% (1,790) | 0.47 |
| High | 77.0% (5,391) | 75.4% (6,354) | 0.02 |

a For 2,585 cases (16.8%), information of admission type is unavailable.

b Only available for in-patient cases and hence not available in 19.3%.

c The hospital volume was categorized with respect to the number of first admissions per hospital during the

Table 2.

| | **Admissions until the nadir week, 3rd April – 9th April 2020** | | | | **Admissions until the final week, 10th July – 16th July 2020** | | | |
|---|---|---|---|---|---|---|---|---|
| | Expected | Observed | CumHD (95% CI) | P Value | Expected | Observed | CumHD (95% CI) | P Value |
| AF admissions (total) | 1872 | 1296 | -31% (-34; -27) | < 0.001 | 8424 | 7001 | -17% (-18; -15) | < 0.001 |
| Prevalent AF admissions | 760 | 663 | -13% (-18; -8) | < 0.05 | 3420 | 2941 | -14% (-16; -12) | < 0.001 |
| Incident AF admissions | 1112 | 633 | -43% (-48; -38) | < 0.001 | 5004 | 4060 | -19% (-21; -17) | < 0.001 |

AF = Atrial fibrillation or atrial flutter, CumHD = cumulative hospitalisation deficit

Table 3.

| | Study | Control | Odds ratio (95% CI) | *P* Value |
|---|---|---|---|---|
| Early phase | | | | |
| Transesophageal echocardiogram | 462 (34.7%) | 964 (41.4%) | 0.74 (0.64−0.86) | < 0.01 |
| Cardioversion | 540 (40.6%) | 924 (39.7%) | 1.08 (0.94−1.25) | 0.27 |
| Catheter ablation | 288 (21.6%) | 491 (21.1%) | 0.98 (0.82−1.17) | 0.82 |
| Late phase | | | | |
| Transesophageal echocardiogram | 2,262 (39.9%) | 2,450 (40.2%) | 0.96 (0.88−1.03) | 0.26 |
| Cardioversion | 2,188 (38.6%) | 2,286 (37.5%) | 1.06 (0.98−1.14) | 0.17 |
| Catheter ablation | 1,299 (22.9%) | 1,309 (21.5%) | 1.05 (0.96−1.16) | 0.28 |