Nursing Home Admission and Initiation of Domiciliary Care Following Infective Endocarditis

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ABSTRACT

Background: Infective endocarditis (IE) may cause debilitating physical and mental changes that can interfere with activities of daily living. Admission to a nursing home and need for domiciliary care following hospitalization for IE represent such relevant outcomes, yet no such data have been reported.

Methods: Using Danish nationwide registries, we identified all patients discharged alive after a first-time IE hospitalization in the period 1996 to 2014. These were matched by age, sex, calendar year, and relevant comorbidities with the background population in a 1:1 ratio. The 1-year rate of nursing home admission and initiation of domiciliary care, respectively, were assessed by multivariable Cox regression analyses.

Results: In total, 4,493 IE patients were matched with 4,493 control subjects from the background population (median age: 66.8 years; interquartile range: 54.1, 76.7; 67.8% men). The 1-year incidence of nursing home admission was significantly higher among IE patients compared with the matched population (3.4% vs. 1.0%; hazard ratio: 7.95; 95% confidence interval: 4.00−15.77). Furthermore, IE patients had an increased use of domiciliary care compared with the matched population (6.6% vs. 2.1%; hazard ratio: 4.39; 95% confidence interval: 2.74−7.05). Factors associated with an increased risk of nursing home admission and domiciliary care among IE patients included older age, living alone, longer length of hospital stay, cardiovascular comorbidities, and stroke during admission.

Conclusions: Patients who survived IE had an 8× higher incidence of nursing home admission and a 4× higher incidence of initiation of domiciliary care than their counterparts from the matched population.

Infective endocarditis (IE) is associated with high morbidity and mortality [1-4]. The annual incidence of IE ranges from 3 to 7 per 100,000 person-years [2,5] with an in-hospital mortality between 10% and 25% [6]. Patients surviving IE may undergo permanent physical and mental changes, and, consequently, they may not be capable of carrying out activities of daily living or managing independently at home [7]. Thus, IE patients may be compelled to receive professional help at home such as domiciliary support or at institutions such as a nursing home. However, the degree to which these services are needed is yet unknown in this setting. The need of professional help in daily life can cause a feeling of stigmatization and loss of autonomy, independence, and self-esteem. Furthermore, it may lead to separation from family, lack of affiliation, and a feeling of loneliness and unhappiness [7]. Hence, studying such outcomes may assess an important and traditionally unmeasured angle of this serious disease that could help enlighten the severity of IE and the need for surveillance of vulnerable individuals for purposes of primary, secondary, and tertiary prevention. This Danish nationwide real-life study sets out to investigate the extent of these consequences of IE using cross-linkage of health and administrative registries.

METHODS

The Danish health care and social welfare system

The Danish health care system, financed by taxes, provides equal access to health care and welfare benefits including domiciliary care and nursing home admission to every Danish resident.

Data sources

A unique and permanent civil registration number is assigned to all Danish residents allowing accurate linkage of nationwide administrative registries at an individual level. The Danish National Patient Registry holds information on all hospital admissions and diagnoses (coded according to the *International Classification of Diseases*, eighth and tenth revisions) since 1978, and surgical procedures (coded according to the Nordic Medico-Statistical

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Committee Classification of Surgical Procedures) since 1996. The Danish National Prescription Registry holds information on all claimed prescriptions since 1995 (coded according to the Anatomical Therapeutic Chemical classification) including date of drug dispensation, strength, and quantity [8]. The Danish National Population Registry holds information on vital status and on all deaths. Statistics Denmark holds information on nursing home admissions and domiciliary care since 1994 and 2008, respectively [9]. Furthermore, Statistics Denmark also holds information on marital status and income.

Study population

In the main analysis, in which the risk of nursing home admission is evaluated, the study population comprised patients with a first-time discharge diagnosis of IE in the period January 1, 1996, to December 31, 2014. In a supplementary analysis addressing the risk of initiation of domiciliary care, the study population comprised patients with a first-time discharge diagnosis of IE in the period January 1, 2008, to December 31, 2014. The study population was defined from the following *International Classification of Diseases, Tenth Revision* codes (I33, I38, and I398). These codes have been validated and found to have a positive predictive value of 82% in the Danish National Patient Registry [10]. However, to improve the likelihood of the diagnosis, patients who were hospitalized for <14 days or died during hospitalization were excluded from the study. In Denmark, IE treatment is carried out in-hospital solely. Each patient was matched with 1 control subject from the general population based on age, sex, calendar year, and relevant comorbidities (i.e., ischemic heart disease, chronic heart failure, cerebral vascular disease, atrial fibrillation, hypertension, malignancy, chronic renal failure) using risk-set matching. Patients and control subjects who had been living in a nursing home prior to IE hospitalization were excluded from the main analysis, whereas patients and control subjects who had been living in a nursing home or received domiciliary care prior to IE hospitalization were excluded from the supplementary analysis. Patients and control subjects were followed from index (date of discharge for IE patients and a corresponding date for the control subjects) until occurrence of an outcome of interest (i.e., initiation of domiciliary care or admission to a nursing home), death, a maximum of 1-year of follow-up, or end of follow-up (December 31, 2015), whichever came first.

Covariates

Comorbidities were identified by hospital discharge codes any time prior to and including the IE hospitalization for IE patients and any time prior to the index date for control subjects. Patients with diabetes and hypertension were identified using claimed drug prescriptions as done previously [11]. Surgical procedures were assessed prior to and during IE hospitalization. Concomitant pharmacotherapy was defined by at least 1 filled prescription in the period 6 months prior to hospital admission. Furthermore, average 5-year household income prior to discharge was calculated and graded in quartiles.

Outcomes

The primary outcomes of interest were admission to a nursing home and initiation of domiciliary care. A secondary outcome was all-cause mortality. A nursing home is an institution where people are offered to live if they are unable to take care of themselves and so it has the purpose of avoiding loneliness, boredom, and helplessness [12]. Domiciliary care is defined as help administered to people unable to perform necessary activities of daily living themselves. Domiciliary care in Denmark includes 3 areas: 1) personal care including assistance showering, dressing, and eating; 2) practical help including shopping, cleaning, and doing laundry; and 3) food service [13].

Sensitivity analysis

For purposes of sensitivity, an analysis with a composite endpoint of nursing home admission and initiation of domiciliary care for the period 2008 to 2014 was conducted.

Statistical analysis

Baseline characteristics for IE patients and control subjects were described by use of frequencies and percentages for categorical variables and medians with interquartile ranges for continuous variables. Differences in baseline characteristics between IE patients and control subjects were tested using the chi-square test for categorical variables and the Mann-Whitney *U* test for continuous variables. The cumulative incidences of nursing home admissions were estimated using the Aalen-Johansen estimator incorporating competing risk of death. Likewise, the cumulative incidences of initiation of domiciliary care were estimated using the Aalen-Johansen estimator incorporating competing risk of death and nursing home admission. The differences between the cumulative incidences of nursing home admissions and initiation of domiciliary care, respectively, among the IE patients and control subjects were assessed using the Gray test. The incidence of all-cause mortality was estimated using the Kaplan-Meier estimator and differences between the IE patients and control subjects were assessed using the log-rank test. Furthermore, hazard ratios (HR) were calculated to compare the risk of outcomes between IE patients and control subjects using multivariable cause-specific Cox regression models conditional on the matching (i.e., comparing cases with their matched control subjects), adjusted for civil status, comorbidities, and concomitant pharmacotherapy. In addition, multivariable Cox regression was also applied to identify baseline characteristics associated with the need of nursing home admission or domiciliary care. The proportional hazards assumption was tested and found valid. Relevant

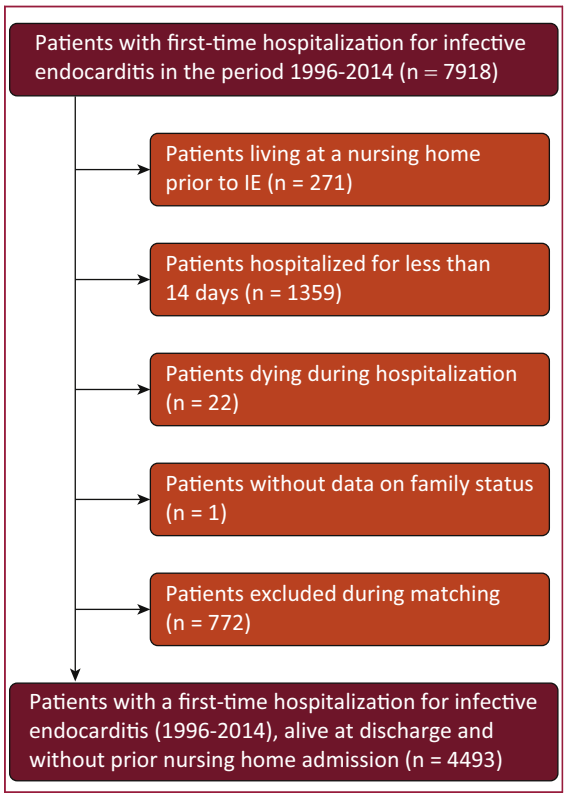

FIGURE 1. Selection of the study population.

interactions were tested and found not significant, unless otherwise stated. All statistical analyses were performed with SAS statistical software version 9.4 (SAS Institute, Cary, NC, USA). A 2-sided p value <0.05 was considered statistically significant.

RESULTS

Baseline characteristics

In total, 5,265 patients were discharged alive with an IE diagnosis between 1996 and 2014 and no prior nursing home admission. During matching, 772 IE patients were excluded due to old age, high degree of comorbidities, and concomitant pharmacotherapy unmatchable with the background population. Thus, in total 4,493 patients discharged alive with an IE diagnosis between 1996 and 2014 and no prior nursing home admission were included in the study (Fig. 1).

Table 1 summarizes baseline characteristics of the patients and matched control subjects. The median age of the study population was 66.8 years (interquartile range: 54.1, 76.7), and 67.8% were men.

IE patients had a higher frequency of cardiovascular comorbidities, higher use of concomitant pharmacotherapy, and were more likely to be living alone than their matched control subjects were. In the supplementary analysis on domiciliary care, 3,935 patients discharged with an IE diagnosis between 2008 and 2014 and no prior admission to a nursing home or initiated domiciliary care were included in the study. Online Table 1 summarizes baseline characteristics of the patients and matched control subjects for the period 2008 to 2014.

TABLE 1. Baseline characteristics

Variable	IE Patients	Control Subjects	p Values
Number	4,493	4,493	
Median age (IQR)	66.8 (54.1, 76.7)	66.9 (54.0, 76.7)	1.0
Male	3,045 (67.8)	3,045 (67.8)	1.0
Income group			0.02
Q1 (lowest)	955 (21.3)	842 (18.7)	
Q2	891 (19.8)	907 (20.2)	
Q3	863 (19.5)	940 (20.9)	
Q4 (highest)	874 (19.5)	917 (20.4)	
Ischemic heart disease	1,163 (25.9)	1,163 (25.9)	1.0
Cerebral vascular disease	652 (14.5)	652 (14.5)	1.0
Atrial fibrillation	974 (21.7)	974 (21.7)	1.0
Peripheral vascular disease	304 (6.8)	162 (3.6)	<0.0001
Chronic renal failure	182 (4.1)	182 (4.1)	1.0
Diabetes mellitus	536 (11.9)	440 (9.8)	0.001
Chronic obstructive lung disease	487 (10.8)	309 (6.9)	<0.0001
Dementia	18 (0.4)	17 (0.4)	0.9
Liver disease	236 (5.3)	66 (1.5)	<0.0001
Malignancy	611 (13.6)	589 (13.1)	0.5
Congenital heart disease	49 (1.1)	7 (0.2)	<0.0001
Valve insufficiency and stenosis	2,053 (45.7)	203 (4.5)	<0.0001
Prior valve surgery	546 (12.2)	58 (1.3)	<0.0001
Prior PM or ICD	354 (7.9)	119 (2.7)	<0.0001
Prior stroke	325 (7.2)	515 (1.5)	<0.0001
Prior CHF	637 (14.2)	637 (14.2)	1.0
Hypertension	2,285 (50.9)	2,285 (50.9)	1.0
Concomitant pharmacotherapy			
Statins	1,082 (24.1)	1,194 (26.6)	0.007
Beta-blockers	1,618 (36.0)	1,339 (29.8)	<0.0001
Calcium channel blockers	967 (21.5)	1,051 (23.4)	0.03
Renin-angiotensin system inhibitors	1,582 (35.2)	1,716 (38.2)	0.003
Clopidogrel	198 (4.4)	155 (3.5)	0.02
Anticoagulants	1,595 (35.5)	562 (12.5)	<0.0001
Acetylsalicylic acid	1,458 (32.5)	1,303 (29.0)	0.0004
Thiazides	716 (15.9)	797 (17.7)	0.02
Marital status			
Living alone prior to hospitalization	1,823 (40.6)	1,446 (32.2)	<0.0001

Values are n (%), unless otherwise indicated.
CHF, congestive heart failure; ICD, implantable cardioverter-defibrillator; IE, infective endocarditis; IQR, interquartile range; PM, pacemaker; Q, quartile.

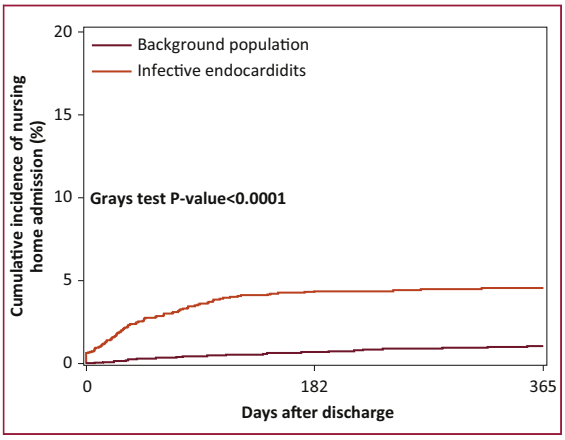

FIGURE 2. Cumulative incidences of nursing home admission.

Nursing home admission and mortality

The 1-year cumulative incidence of nursing home admission was 3.4% among IE patients and 1.0% among control subjects ($p < 0.0001$) (Figure 2). In adjusted analysis, IE was associated with an increased risk of nursing home admission (HR: 7.95; 95% confidence interval [CI]: 4.00—15.77; $p < 0.0001$). Factors associated with nursing home admission included advanced age, living alone, longer length of hospital admission, prior heart failure, prior pacemaker or implantable cardioverter-defibrillator, and stroke during admission (Figure 3). Furthermore, the 1-year mortality rate was 13.4% among IE patients and 3.8% among control subjects ($p < 0.0001$) (Figure 4). In adjusted analysis, IE was associated with an increased risk of death compared with control subjects (HR: 3.62; 95% CI: 2.85—4.60; $p < 0.0001$).

Initiation of domiciliary care

The 1-year cumulative incidence of initiation of domiciliary care was 6.6% and 2.1% among IE patients and control subjects, respectively ($p < 0.0001$) (Online Figure 1). In adjusted analysis, IE was associated with an increased risk of initiation of domiciliary care (HR: 4.39; 95% CI: 2.74—7.05; $p < 0.0001$). Furthermore, Online Table 2 shows the distribution of different domiciliary care services among IE patients and control subjects. All types of care services were more frequent among patients than among control subjects. Factors associated with initiation of domiciliary support included older age, living alone, longer length of hospital admission, hypertension, malignancy, and stroke during admission (Online Figures 1 and 2).

Sensitivity analysis

Analyzing the composite endpoint of nursing home admission and initiation of domiciliary care similar results was found. The 1-year incidence of the composite endpoint was significantly higher among IE patients than among the background population (8.7% vs. 2.7%; HR: 3.42; 95% CI: 2.68—4.35; $p < 0.0001$).

DISCUSSION

In this study, we examined the relationship between first-time IE hospitalization and admission to a nursing home or initiation of domiciliary care within 1 year after discharge compared with the general population. The absolute rate of nursing home admission was approximately 1 in 29 patients over 1 year, whereas the absolute rate of initiation of domiciliary care was approximately 1 in 15 patients over 1 year. These results emphasize the possible debilitating consequences of IE on patients' ability to carry out daily life activities and to manage independently at home. Factors associated with nursing home admission as well as initiation of domiciliary care included older age, living alone, longer length of hospital admission, cardiovascular comorbidities, and stroke during admission.

The 3 main complications of IE are heart failure, uncontrolled infection, and embolic events [6,14]. Symptomatic neurologic events affect 15% to 30% of all IE patients and additional clinically silent cerebral events are frequent [14]. Neurologic events include stroke, transient ischaemic attack, intracerebral or subarachnoid hemorrhage, development of brain abscess, meningitis, and toxic encephalopathy [5,6,14]; hence, symptoms may significantly limit functional capacity and the ability to carry out daily living activities and to manage independently at home. Other frequent complications include infectious aneurysms, splenic infarcts, musculoskeletal symptoms, and acute renal failure [14,15]. Previous studies found that stroke is associated with a high prevalence of disabilities, poor functional outcome, and psychosocial problems [16,17]. Likewise, as shown in Figure 3, we found that stroke during admission was associated with an increased need of nursing home admission and initiation of domiciliary care. Hence, as we might expect, those patients who suffer a stroke during the course of IE are among those at highest risk of limited activities of daily living after discharge. Few studies have examined post-discharge domiciliary care needs and nursing home admissions rates; however, studies in heart failure and also after coronary artery bypass graft show similar rates of these outcomes as in our study on IE patients [18,19].

Besides presence or absence of various complications, the patient's functional capacity further depends on comorbidity, physical and mental health, social status, and family status. Older age, longer length of hospital admission, comorbidities, and living alone was associated with the need of help at a nursing home or domiciliary help, emphasizing the role of functional and mental capacity, the severity of the infection, and the role of a supporting spouse [20]. In recent studies, post-discharge mortality rates in endocarditis patients have been reported to range from 2% to 24% [3,15], and from 29% to 84% in critically ill patients [14]. In our study, we found 1-year mortality rate of 15.3% among

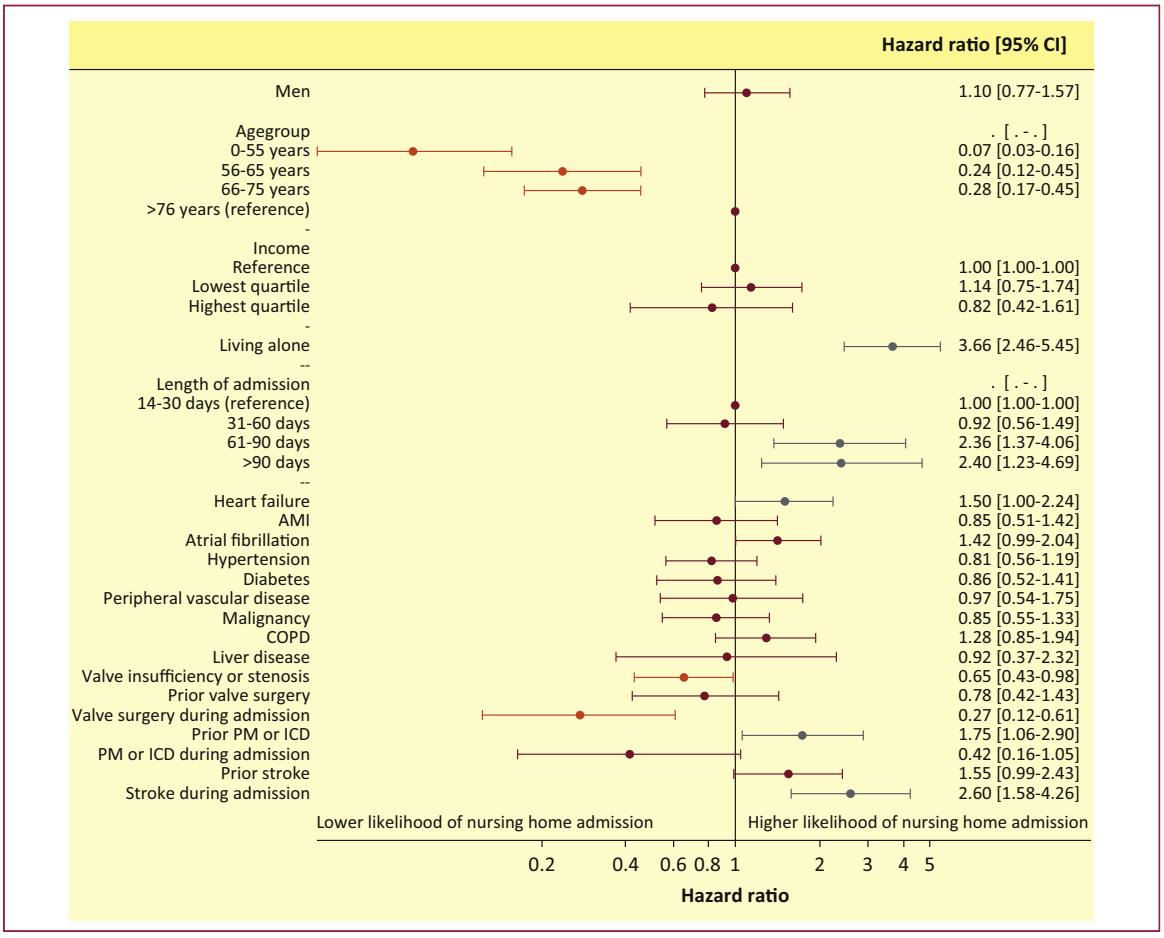

FIGURE 3. Factors associated with nursing home admission in infective endocarditis patients. AMI, acute myocardial infarction; CI, confidence interval; COPD, chronic obstructive pulmonary disease; ICD, implantable cardioverter-defibrillator; PM, pacemaker.

patients alive at discharge. Thus, the findings in this study enlighten the importance of surveillance of vulnerable individuals for purposes of primary, secondary, and tertiary prophylaxis. Preventive interventions through timely diagnosis and initiation of antibiotics and surgery when needed as well as prevention of sequelae in clinical practice could have a significant impact on public health and socioeconomic consequences.

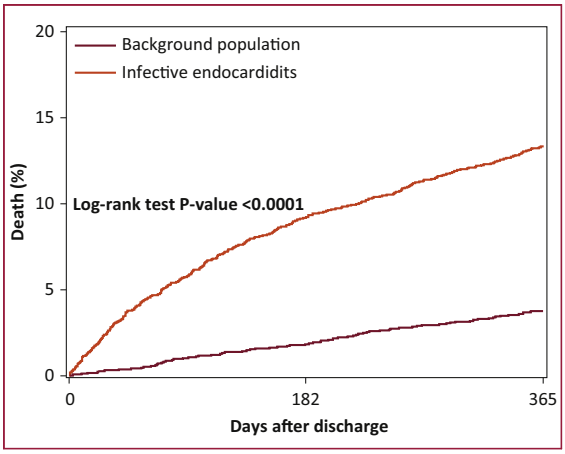

FIGURE 4. Cumulative incidences of death.

Strengths and limitations

The main strength of our study is the completeness of data in a nationwide unselected cohort of IE patients and matched control subjects in a real-life setting. The accuracy of the data relies on the coding in nationwide administrative registries that have been validated previously [10]. The main limitation of the study lies in the observational nature of the study, thus we report associations and not causalities. Hospitalizations during follow-up could be a competing risk, but since the hospitalization itself might be sequelae of IE, this was not taken into account. The Cox analyses were adjusted for relevant demographics, comorbidities, and concomitant medication, yet the influence of potential confounders and thus residual confounding cannot be omitted. Data on nursing

home admissions and domiciliary care were based on Danish health care and social systems and thus may not be fully translated to other countries.

CONCLUSIONS

Patients who survive a first-time IE have an 8× higher incidence of nursing home admission and a 4× higher incidence of initiation of domiciliary care as compared with matched control subjects from the general population. Factors associated with nursing home admission and initiation of domiciliary care included older age, living alone, longer length of hospital admission, cardiovascular comorbidities, and stroke during admission. Hence, infective endocarditis was associated with debilitating physical and mental changes that are necessary to take into account assessing the severity of IE and the follow-up on patients surviving IE.

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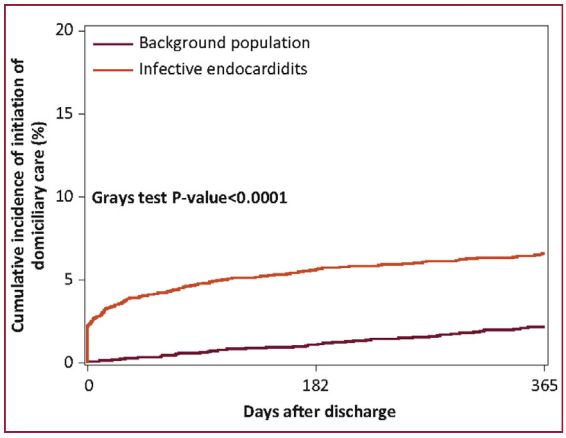
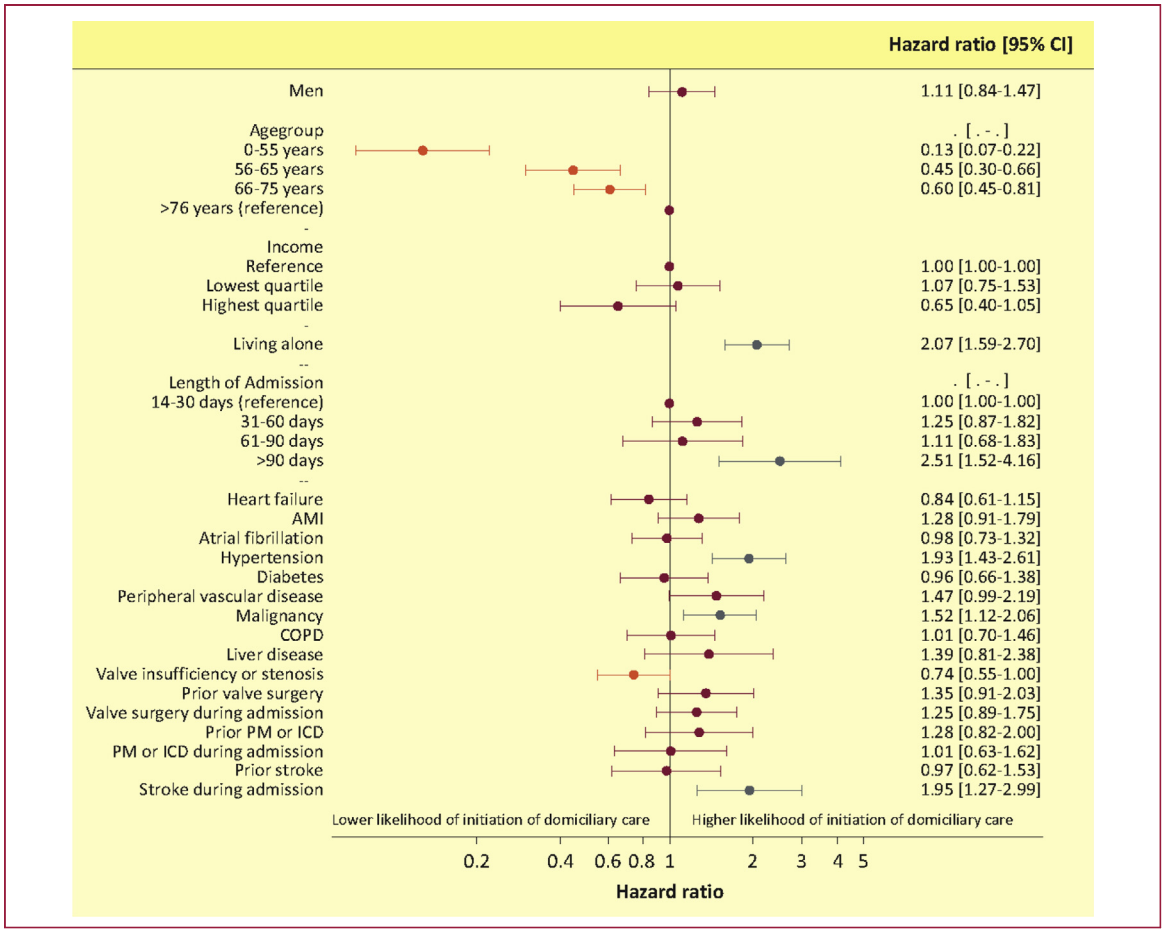
APPENDIX



ONLINE FIGURE 1. Cumulative incidences of initiation of domiciliary care.



ONLINE FIGURE 2. Factors associated with initiation of domiciliary care in infective endocarditis patients. AMI, acute myocardial infarction; CI, confidence interval; COPD, chronic obstructive pulmonary disease; ICD, implantable cardioverter-defibrillator; PM, pacemaker.

ONLINE TABLE 1. Baseline characteristics in supplementary analysis on domiciliary care

Variable	IE Patients	Control Subjects	p Values
Number	3,935	3,976	
Median age (IQR)	65.0 (52.6, 75.0)	65.0 (51.6, 74.9)	0.4
Male	2,743 (69.7)	2,768 (69.6)	0.9
Income group			0.001
Q1 (lowest)	763 (19.4)	651 (16.4)	
Q2	752 (19.1)	782 (19.7)	
Q3	768 (19.5)	885 (22.3)	
Q4 (highest)	839 (21.3)	868 (21.8)	
Ischemic heart disease	951 (24.2)	944 (23.7)	0.66
Cerebral vascular disease	495 (12.6)	473 (11.9)	0.4
Atrial fibrillation	760 (19.3)	735 (18.5)	0.4
Peripheral vascular disease	235 (6.0)	117 (2.9)	<0.0001
Chronic renal failure	137 (3.5)	143 (3.6)	0.8
Diabetes mellitus	413 (10.5)	338 (8.5)	0.003
Chronic obstructive lung disease	366 (9.3)	240 (6.0)	<0.0001
Dementia	11 (0.3)	12 (0.3)	0.9
Liver disease	190 (486)	52 (1.3)	<0.0001
Malignancy	508 (12.9)	484 (12.3)	0.3
Congenital heart disease	49 (1.3)	8 (0.2)	<0.0001
Valve insufficiency and stenosis	1,788 (45.4)	135 (3.4)	<0.0001
Prior valve surgery	427 (10.9)	35 (0.9)	<0.0001
Prior PM or ICD	274 (7.0)	72 (1.8)	<0.0001
Prior stroke	225 (5.7)	361 (9.1)	<0.0001
Prior CHF	506 (12.9)	491 (12.4)	0.5
Hypertension	1,878 (47.7)	1,886 (47.4)	0.8
Concomitant pharmacotherapy			
Statins	848 (21.6)	944 (21.6)	0.02
Beta-blockers	1,334 (33.9)	1,077 (27.1)	<0.0001
Calcium channel blockers	781 (19.9)	888 (22.3)	0.007
Renin-angiotensin system inhibitors	1,315 (33.4)	1,449 (36.4)	0.005
Clopidogrel	146 (3.7)	103 (2.6)	0.04
Anticoagulants	1,396 (35.5)	424 (10.7)	<0.0001
Acetylsalicylic acid	1,174 (29.8)	1,042 (26.2)	0.0003
Thiazides	602 (15.3)	673 (16.9)	0.05
Marital status			
Living alone prior hospitalization	1,440 (36.6)	1,122 (28.2)	<0.0001

Values are n (%) unless otherwise indicated.
CHF, congestive heart failure; ICD, implantable cardioverter-defibrillator; IE, infective endocarditis; IQR, interquartile range; PM, pacemaker; Q, quartile.

ONLINE TABLE 2. Incidence of initiation of domiciliary care

	Events (% of Group)	
	Cases (n = 3935)	Control Subjects (n = 3976)
Domiciliary care	258 (6.6)	84 (2.1)
Personal care	105 (2.7)	24 (0.6)
Practical help	93 (2.4)	40 (1.0)
Personal care and practical help	61 (1.6)	20 (0.5)

Stratification of services based on initial domiciliary care service.