

ORIGINAL RESEARCH

Atrial fibrillation and heart failure in seven nursing homes

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Received: January 5, 2012
DOI: 10.5430/jnep.v2n4p22

Accepted: February 21, 2012
URL: <http://dx.doi.org/10.5430/jnep.v2n4p22>

Published: November 1, 2012

Abstract

Objectives: Previous research suggests that blood-thinning treatment for patients with atrial fibrillation as well as treatment for patients with heart failure is not adequate among the elderly. We tested this among long-term patients in nursing homes.

Methods: Information about the patients (n = 513) was collected during the period March-April 2008. Data collection consisted of electrocardiography, particulars of any stroke suffered and copying medication records. A standardized set of blood samples was analyzed.

Results: Of the 91 atrial fibrillation patients, 14.3% were anticoagulated with warfarin. 42.0% of the patients with atrial fibrillation had no form of antithrombotic treatment. Prevalence of atrial fibrillation was 18.8% and high B-type natriuretic peptide (ProBNP > 225 pmol/L) 13.2%. Of the patients with both stroke and atrial fibrillation, 24.3% were given warfarin. Of the 59 patients with ProBNP > 225 pmol/L and adequate renal function (eGFR > 50 ml/min), 22.0% were given ACE/A2B.

Conclusions: The warfarin treatment rate was lower than recommended for patients with atrial fibrillation in nursing homes, as was probably the use of ACE-inhibitors to heart -failure patients. We found significant differences between the nursing homes with regard to treatment rate. Atrial fibrillation and heart failure case finding and monitoring in nursing homes needs to be improved and simple tools like recording and reporting irregular pulse by doctors and nurses and measure ProBNP on a regular basis may improve this.

Key words

Nursing home, Atrial fibrillation, Heart failure, Drugs, Long-term care, Chronic disease

1 Introduction

Norway has 4.6 million inhabitants, 55 public hospitals, 41,052 nursing home beds and 1,796 beds in old people's homes; 96.8% of nursing home beds are in single rooms and 43.3% of all deaths (total 41,342) are in nursing institutions^[1]. The

healthcare system is split into first and second line services. First line services are administered and financed by the municipalities (N = 431). First line covers general practice (GP) services, mother and child care, home-care and nursing homes (N = 900). The second line contains the 55 hospitals and specialist services (including private specialists). Second line is administered and financed directly by the state.

It is expected that nursing homes will play an important role in healthcare delivery in the years ahead. The population is growing older and patients admitted to hospitals are being discharged earlier. A Norwegian white paper states that a reform is needed to ensure collaboration between primary care and hospitals. After US, Norway (2009) spends the most money per capita on health in the world (www.oecd.org), but does not get the most in return for the investments. Poor cooperation between first- and second line services is regarded as the main obstacle to improvements^[2]. Among several proposals, the white paper points to accomplishments involving early discharges from hospitals to nursing homes which offer more advanced medical care and structured rehabilitation programs than previously. Quality in the nursing homes will thus be under pressure, expectations of services will rise and clinical complexity will grow. New strategies and more knowledge about the nursing home population are needed to meet this situation.

Two of the most frequent diagnoses among the elderly (> 75) are atrial fibrillation (AF) and congestive heart failure. The prevalence of AF has not been studied in Norwegian nursing homes, nor has the way AF is treated. The question of under-treatment of heart failure in nursing homes has been raised earlier^[3].

AF is an independent risk factor for developing a stroke^[4], and in the elderly it is one of the most important causes of stroke^[5]. The current guidelines state that most patients over the age of 75 with atrial fibrillation should be anticoagulated with warfarin. However, increasing age often leads to lower treatment rate than among younger patients^[6, 7]. Stroke risk in AF patients can be estimated using the CHADS2 score, which is a clinical prediction rule for estimating the risk of stroke in patients with non-rheumatic atrial fibrillation^[8]. "Patients are given points on the basis of clinical variables – heart failure: 1 point, hypertension: 1 point, over 75 years of age: 1 point, diabetes: 1 point, previous stroke or transient ischaemic attack (TIA): 2 points. The annual risk of stroke is: CHADS2 score 0: 1.9%, 1: 2.8%, 2: 4.0%, 3: 5.9%, 4: 8.5%, 5: 12.5%, 6: 18.2%". By one (1) point warfarin or aspirin is recommended, by ≥ 2 points warfarin treatment is recommended.

To estimate the risk of bleeding for AF patients on warfarin treatment, bleeding risk scores can be used^[9]: "Bleeding risk score = $0.49 \cdot X$ (Age >70) + $0.32 \cdot X$ (Female) + $0.58 \cdot X$ (Remote bleed) + $0.62 \cdot X$ (Recent bleed) + $0.71 \cdot X$ (Alcohol/Drug Abuse) + $0.27 \cdot X$ (Diabetes) + $0.86 \cdot X$ (Anaemia) + $0.32 \cdot X$ (Antiplatelet), where X equals 1 when the specific characteristic is present and 0 otherwise. Bleeding risk scores of > 1.07, > 1.07 but < 2.19, and > 2.19, respectively, are classified as low, moderate and high risk. Low-risk individuals have 0.9% bleeding risk, moderate-risk 2.0% and high-risk individuals 5.4%". In the study cited the high-risk bleeding individuals (5.6% bleeding risk) had a 7% stroke risk.

Simple diagnostic tests are needed in nursing homes to diagnose the most frequent conditions. Transports to hospitals may be exhausting for frail and old nursing home patients. Research shows that ProBNP, which is an amino acid secreted by the ventricles of the heart in response to excessive stretching of heart muscle cells (cardiomyocytes), provides useful diagnostic information supplementary to clinical examination in order to diagnose untreated heart failure in the elderly^[10]. This refers both to left ventricular function^[11] and diastolic dysfunction^[12]. To monitor heart failure treatment using repeated measurements of ProBNP in blood is probably better than traditional methods like clinical examination and echocardiography^[13].

We wanted to investigate to what degree long-term nursing home residents with AF received antithrombotic treatment and to what extent patients with NT-proBNP above 225 pmol/L were treated with angiotensin-converting enzyme (ACE) inhibitors/A2 blockers, beta-blockers, statins and diuretics, and to shed light on the biasing effect of renal failure, weight and age on ProBNP. We also wanted to study whether there were differences in treatment between the nursing homes.

The study was approved by the Regional Ethics Committee of Western Norway.

2 Materials and methods

Bergen has 250,000 inhabitants and 37 nursing homes (2,300 beds). The number of beds ranges from 20 to 189. Seven nursing homes in Bergen participated in this study. Only long-term patients ($n = 513$) were included. The nursing homes were comparable in terms of nursing staff, financing and gender distribution.

Information about the patients was gathered during the period March-April 2008. 24 medical students conducted the data collection, which consisted of weight, details of any stroke suffered and copying of drug charts. Electrocardiography was conducted to diagnose AF and a standardized set of blood samples were analyzed at the laboratory at the Bethany Hospital (haemoglobin, B-type natriuretic peptide (ProBNP), sodium, potassium, calcium, albumin, creatinine, blood urea nitrogen, urate, estimated glomerular filtration rate (eGFR)). 447 of the patients were blood-tested and 484 ECG'ed. 488 of the patients were weighed. It was possible to conclude if the patient had undergone a stroke in 462 of the patients. Complete medication records existed for all patients.

We used ProBNP > 225 pmol/L to define patients with heart failure. To understand the degree of the biasing effects of age, weight and renal function on ProBNP-levels in this population, we performed bivariate analyses of the factors mentioned and quantified explained variation by the determination coefficient (R^2). We also estimated non-parametric correlation (Spearman's) between ProBNP and eGFR, as renal function is considered the most important biasing factor for ProBNP. To try to find a predictive equation taking all biasing factors into consideration, a multiple linear regression analysis of the square root of proBNP on age, weight and the square root of eGFR was performed.

The recorded data were keyed into an Excel worksheet and the drugs coded according to the Anatomical Therapeutic Chemical Drug Register (ATC). Frequency counts were performed in Excel, but the statistical analysis software JMP version 8 (from SAS), was used for general statistical analysis. To analyze differences in average of continuous data (e.g. ProBNP) the Tukey-Kramer (Honestly Significant Difference) multiple-comparison method was used as a parametric method (- assumes that the data has come from a type of probability distribution and makes inferences about the parameters of the distribution) and the Wilcoxon test as a non-parametric method (- which do not rely on assumptions that the data are drawn from a given probability distribution). Pearson's chi-square test was used to analyze ordinal and nominal data. Results were reported as odds ratios (OR) or relative risks (RR) with 95% confidence intervals (CI), estimated directly from 2×2 tables. All tests were done at the 5% significance level.

3 Results

513 long-term patients residing in seven nursing homes were included. 69% were women, 31% men. The mean age was 84.1 years. Nursing home characteristics are demonstrated in Table 1 and use of cardiovascular drugs are shown in Table 2.

3.1 Atrial fibrillation

91 (18.8%) of the 484 patients with recorded electrocardiography had AF. There was no significant difference in the occurrence of AF among nursing homes (Pearson's chi-square test: $p = 0.4858$). 13 (14.3%) of the 91 AF patients were anticoagulated with warfarin, 85.7% (78) were not. AF patients were given ASA more than the group without AF (OR = 1.73, 95% CI: (1.07, 2.78), Pearson's chi-square test: $p = 0.0231$).

There were significant differences in warfarin treatment to AF-patients among nursing homes (from 0 to 50%) as demonstrated in Figure 1.

The average CHADS2 score for AF patients (91) was ranged from 4 - 6, which corresponds to an annual stroke risk of 8.5-18.2%. These estimates were based on counting score-giving parameters: Most of the AF patients were older than 75 years old (87%), giving CHADS2 score "1". We found that 41% of AF patients had undergone a stroke before, 30% had ProBNP > 225 pmol/l, 30% were given ACE inhibitors/A2 blockers, 13% anti-diabetics, 57% diuretics, 23% beta-blockers and 12% calcium antagonists, all indicating score-giving illness according to the CHADS2 score.

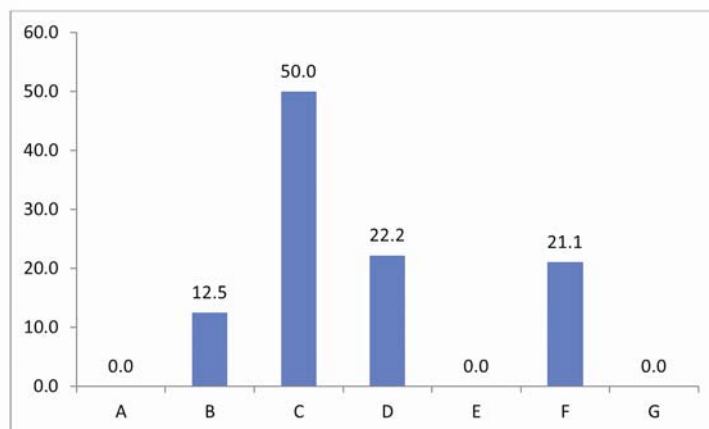


Figure 1. Percentage of long-term patients with atrial fibrillation (N=91) receiving warfarin in 7 nursing homes (A, B,...) in Bergen, Norway (Pearson's chi-square test: $p = 0.0391$).

Table 1. Characteristics of the 7 nursing homes with long-term patients participating in the city of Bergen, Norway, in 2008 (N =513 long-term patients)

Nursing home	A	B	C	D	E	F	G	Total	P
N	83	77	39	85	82	101	46	513	
No. of places (total/long/short)	108/88/20	84/63/21	66/31/35	90/90/0	107/81/26	131/99/32	64/18/46	650/500/150	
Location in city	suburb	inner city	suburb	suburb	inner city	suburb	suburb		
Doctors' hours per place per week	0.4	0.3	0.5	0.3	0.4	0.4	0.5	0.4	
Men (%)	33.7	33.8	28.2	26.7	21.0	37.6	30.4	30.2	0.273*
Age (years)									
Mean	86.7	85.2	84.7	84.9	88.2	79.6	82.2	84.4	<0.001**
Standard deviation	7.6	10.7	7.5	9.1	6.8	15.7	10.0		
Length (days)									
Mean	990.0	901.5	973.1	946.1	1728.9	1383.1	1055.2	1171.5	<0.001**
Standard deviation	1102.9	1038.9	747.8	849.6	1075.2	1299.9	873.43		
Non-demented n=511 (%)	20.7	31.6	0.0	29.4	41.5	20.8	19.6	23.4	<0.001*
Deviation (%)	-2.7	8.2	-23.4	6.0	18.1	-2.6	-3.8		
Suffered stroke n=426 (%)	32.4	10.2	28.2	35.4	21.5	30.0	15.4	24.7	0.009*
Deviation (%)	7.7	-14.5	3.5	10.7	-3.2	5.3	-9.3		

*Pearson Chi-square; **Kruskal-Wallis test

Table 2. Use of cardiovascular drugs for long-term patients in 7 nursing homes in Bergen, Norway. Left column shows the different Anatomical Therapeutic Chemical (ATC) drug groups. For each drug group and nursing home the percentage of patients using drugs within the relevant group is shown along with the deviation from the expected average.

Nursing home	A	B	C	D	E	F	G	All
N	83	77	39	85	82	101	46	513
ATC drug group								
C09, ACE/A2B, ACEI and A2 –blockers (%)	14.46	12.99	17.95	21.18	9.76	17.82	19.57	16.25
deviation	-1.79	-3.26	+1.70	+4.93	-6.49	+1.57	+3.32	
B01A, antithrombotics (%)	21.69	46.75	43.59	43.53	29.27	27.72	50.00	37.51
deviation	-15.82	+9.24	+3.09	+6.08	-8.24	-9.79	+12.49	
B01A, Albyl (%)	20.48	41.56	23.8	35.29	24.39	19.80	47.83	30.45
deviation	-9.97	+11.11	-6.65	+4.84	-6.06	-10.65	+17.38	
B01AA03, warfarin (%)	3.23	3.90	15.38	5.88	0.22	3.96	2.17	4.96
deviation	-1.73	-1.06	+10.42	+0.92	-4.74	-1.00	-2.79	
C03, diuretics (%)	38.55	33.77	48.72	45.88	50.0	25.74	26.09	38.80
deviation	-0.25	-5.03	+9.92	+7.08	+11.20	-13.06	-12.71	
C07, beta-blockers (%)	13.25	20.78	23.08	24.71	13.41	15.84	19.57	18.66
deviation	-5.41	+2.12	+4.42	+6.05	-5.25	-2.82	+0.91	
C08, calcium channel blockers (%)	7.23	12.99	2.56	9.41	7.32	3.96	8.70	7.45
deviation	-0.22	+5.54	-4.89	+1.96	-0.13	-3.49	+1.25	

120 (23.4%) of the total cohort (N = 513) had at least one incident of stroke. 67 (55.8%) of patients who had suffered a stroke received some kind of antithrombotic treatment (ATC = B01A). 10 (8.3%) of these patients were given warfarin. 9 (24.3%) of 37 patients with both stroke and AF were given warfarin while 27 (73.0%) were given warfarin or some other antithrombotic treatment (B01AB/B01AC).

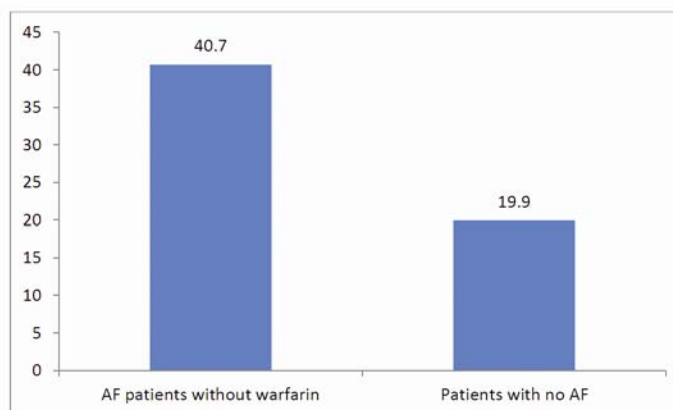


Figure 2. Difference in prevalence (%) of stroke suffered, between patients with AF without warfarin (37/91) as compared with patients without AF (78/391) among long-term nursing home patients in Bergen, Norway. ($p < 0.0001$, 95% CI 9.74% to 32.27%).

Patients with AF not receiving warfarin had strokes significantly more often ($37/91 = 40.7\%$) than those without AF ($78/391 = 19.9\%$) ($N = 484$, odds ratio = 2.75, 95% CI: (1.69, 4.47), Pearson's chi-square: $p < 0.0001$). Patients with AF were 2.75 times more likely to have a stroke suffered than patients without AF (see Figure 2).

3.2 Heart failure / ProBNP

59 (13.2%) of the patients had ProBNP > 225 pmol/L. The average ProBNP value for all patients was 112.7 pmol/L ($N = 447$, SD 174.8, 95% CI: 96.5 to 129.0). There was no difference in average ProBNP values among nursing homes (ANOVA with Tukey-Kramer). Of cardiovascular related drugs, diuretics and heart glycosides were used significantly more in patients with ProBNP > 225 pmol/L. Of the 36 patients with ProBNP > 225 pmol/L and adequate renal function ($eGFR > 50$ ml/min.), 8 (22.0%) were given ACE/A2B. The different cardiovascular drugs used in patients with ProBNP > 225 pmol/L is presented in Figure 3.

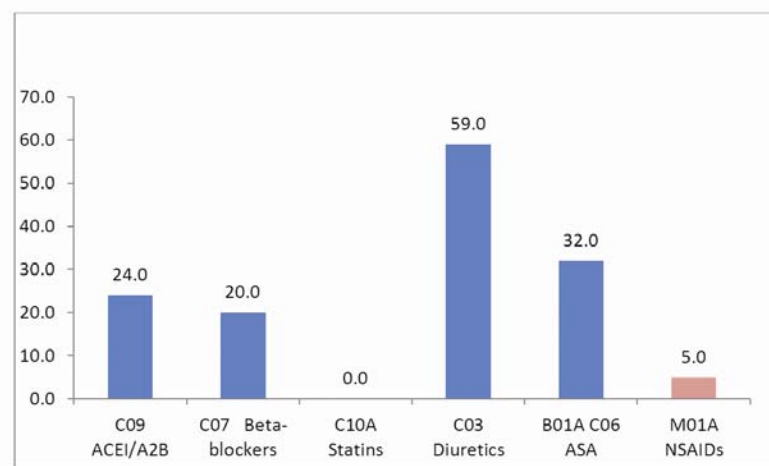


Figure 3. Percentage of patients with ProBNP > 225 pmol/l ($N=59$) using different heart failure treatments and NSAIDs (which are probably contraindicated).

Comparing the proportion patients using ACE -inhibitor or A2-blocker between the two groups of patients; A, with high proBNP (> 225 pmol/L) and adequate renal function ($eGFR > 60$ ml/min), (7/22) and B; those not having high ProBNP but adequate renal function (66/353), no significant difference was found (Pearson's chi -square test: $p = 0.2370$).

Patients younger than the median age ($N = 221$, 86.5 Years) had an average ProBNP of 77 pmol/L and patients older than the median age ($N = 225$) had an average ProBNP of 145 pmol/L (Wilcoxon $p < 0.0001$). Patients less than the median weight (61.1 kg) had an average ProBNP of 125 pmol/L and patients more than the median weight had an average ProBNP = 96 pmol/L (Wilcoxon, $p < 0.0001$).

Spearman's correlation between ProBNP and eGFR was -0.3914 ($n = 446$; $p < 0.001$) and doing a linear regression for $\sqrt{\text{proBNP}}$ on $\sqrt{\text{eGFR}}$ gave the following equation:

$$\sqrt{\text{proBNP}} = 19.457163 - 1.267237 \times \sqrt{\text{eGFR}}$$

and an R-squared of 0.1234 (see Figure 4). Having adequate renal function ($eGFR > 60$ ml/min) thus predicted a ProBNP < 92.93 pmol/l ($= 19.457163 - 1.267237 \times \sqrt{60}$) and $eGFR = 12.37$ ml/min is the renal function which predicts a ProBNP = 225 pmol/l ($x = ((\sqrt{225} - 19.457163) / 1.267237)^2 = 12.3709014$). No patients in our cohort ($N = 513$) had an eGFR that low.

From a multiple linear regression analysis of the square root of proBNP on age, weight and the square root of eGFR we found the following prediction equation:

$$\text{ProBNP} = (17.651306 + 0.0630223 \times \text{age} - 0.070138 \times \text{weight} - 1.17 \times \sqrt{\text{eGFR}})^2$$

For example for an 80-year-old patient weighing 70 kg and having eGFR = 30 the predicted ProBNP is 129.39 pmol/L.

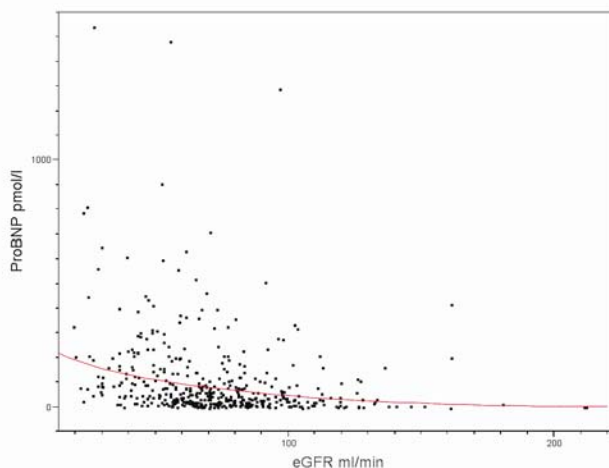


Figure 4. Correlation between ProBNP and eGFR among 446 long-term patients in nursing homes in Bergen, Norway (median age 86.5 years, median weight 61.2 kg). Linear regression for $\sqrt{\text{proBNP}}$ on $\sqrt{\text{eGFR}}$ gave the following equation: $\sqrt{\text{proBNP}} = 19.457163 - 1.267237 \times \sqrt{\text{eGFR}}$ and an R-squared of 0.1234. eGFR 12.37 ml/min. is the renal function which predicts a ProBNP = 225 pmol/L ($x = ((\sqrt{225}) - 19.457163) / 1.267237)^2 = 12.3709014$). eGFR 60 ml/min. predicts ProBNP 92.93 pmol/L.

4 Discussion

The prevalence of AF among long-term nursing home residents was 18.8% (91 of 484 ECG'ed). Of these patients, 14.3% (13) were treated with warfarin and 41.8% (38) had no antithrombotic treatment at all. The estimated CHADS2 score-based annual stroke risk for this AF-population was between 8.5 and 18.2%. Of 36 patients with ProBNP > 225 pmol/l and adequate renal function, 22.0% were treated with ACEI/A2B. There were significant differences in treatment of AF and use of heart failure drugs in patients with ProBNP > 225 pmol/L among nursing homes in the study.

The role of nursing homes in the delivery of social and healthcare services differs among countries as well as within countries. These differences may influence the health issue landscape and composition of staff. Thus comparisons and generalizations based on our findings should be made with care.

5 Limitations of the study

It may be claimed that using ProBNP as the only parameter to diagnose insufficiently or non- treated heart failure weakens the study and most procedures in force recommend echocardiogram to diagnose heart failure. On the other hand, an echocardiogram is often impractical as a diagnostic tool for nursing home patients both due to equipment price and physician qualifications. Transporting patients to a specialist cannot always be recommended for these frail patients either.

The cut-off value of ProBNP as a diagnostic tool for heart-failure in need of treatment, in different populations, is a matter of discussion. The high median age in our cohort made us go for a relatively high cut-off value (as increasing age leads to increasing ProBNP levels) even though that weakened sensitivity of the test. The main purpose of our study was however to examine if under-treatment existed in heart failure patients. Therefore, specificity (the proportion of negatives in the test which are correctly identified) was more important than sensitivity (proportion of actual positives which are correctly identified). We needed to be fairly sure to exclude healthy patients, missing some sick patients however, strengthens the under-treatment conclusion.

The identified risk by elevated ProBNP, whether it's a risk for death or a risk for heart failure hospitalization, lower values are better, higher values are worse. What one also knows, based on the data from Val-HeFT, is that while a single measurement is useful, serial measurements seem to inform even better prognostic value. This also refers to patients above 75^[14-16].

Cut-off limits of ProBNP as a diagnostic and prognostic tool in heart failure are discussed in numerous studies. In one study (mean age 73 years, followed for 6 years and registering all cardiovascular mortality) persons with ProBNP above 200 pmol/L had higher mortality^[17]. In another study, 24 out of 25 patients were classified correctly with regard to heart failure, as compared with cardiac echo, using a ProBNP cut-off of 223 pmol/L^[10].

Our results of bivariate fits of ProBNP by eGFR, weight and age (which are the known biasing factors), lead us to the conclusion that nursing home patients with a ProBNP > 225 pmol/L were more likely to have heart failure and, above this level, the high ProBNP values were not caused by high age, low weight or renal failure.

5.1 Atrial fibrillation

We found that 18.8% (91) of the patients had AF in our study population. The prevalence of AF has been found to be 17% for patients over 65 years and to increase with age^[18]. Our prevalence is comparable to earlier findings and age groups. Patients with AF, older than 65, have been consistently undertreated with anticoagulants^[19]. This is consistent with our finding that the warfarin treatment rate was low (14.3%). Even a warfarin treatment rate of about 65% of elderly AF-patients is considered problematic by several authors^[9, 20]. In our study, we found a significant increase in stroke prevalence in AF patients not treated with warfarin, which illustrates under-treatment. Reasons for low treatment rates might be fear of intracranial haemorrhage and falls^[20] but with systematic monitoring the risks associated with oral anticoagulation treatment appears to be low^[21]. To start life-prolonging treatments may not always be as obvious to do in nursing home patients compared to younger patient groups. Suffering involved with stroke is considerable, however, and should be prevented if possible, at all ages.

Based on our estimates the stroke risk among nursing home residents with AF was 8.5-18.2%, considerably above 5.6% which is considered the highest bleeding risk score according to Shireman et al.^[9]. Increased risk of bleeding episodes on warfarin treatment usually occurs among the elders aged within two months of start-up^[22]. On the other hand, increased CHADS2 score (4-6) in the oldest (>85) population may increase bleeding risk^[23]. Treatment must always be individualized therefore.

McCormick et al.^[24] found that AF was present in 429 (17%) of 2,587 long-term care residents. Overall, 42% of these AF patients were receiving warfarin. This is consistent with our study when it comes to AF prevalence and more in line with our own opinion of a reasonable treatment level of frail nursing home patients than our own findings.

5.2 Heart failure / ProBNP

We found 13.2% (59) had a higher ProBNP (> 225 pmol/L). 8-10% was the prevalence rate for heart failure in earlier studies^[25]. Only ten (16.7%) of the patients were given both ACE/A2B and diuretics, which suggests under-treatment. This impression is reinforced by the lack of significant ACE/A2B differences in treatment rates between the patient group

with high ProBNP and normal renal function (eGFR > 60 ml/min – giving a therapeutic indication without renal contraindication) compared to the rest of the cohort.

A high proportion of renal failure among the elderly has been considered to engender reservations in prescribing ACE inhibitors for this patient group^[26]. However, it is not appropriate to withhold ACE inhibitors for heart failure in patients with only mild renal failure^[27, 28]. Our findings show a low treatment rate in patients with adequate renal function as well.

6 Improvement strategies

It has been claimed that the marginalization of physicians in the nursing home is threatening the overall care of increasingly frail nursing home residents who have medically complex illnesses^[29]. Staffing by trained doctors seems to be needed as well as training programs in treatment guidelines for AF and heart failure. Modern technological tools may be a way to increase treatment rate of warfarin to AF patients and ACE-inhibitors and A2-blockers to heart failure patients. Electronic patient records with reminders (e.g. “this patient has ProBNP > 250 pmol/L and normal renal function but receives no ACE-inhibitor or A2-blocker”) have been proven effective in general practice and hospitals^[30, 31]. Until now such tools have only been used or tested in a limited number of nursing homes^[32].

7 Conclusion

Long-term patients with atrial fibrillation and heart failure in nursing homes are treated inadequately and dissimilarly. Strategies are needed to improve quality of cardiovascular treatments. Recording the irregular patient pulse by nurses and doctors and measuring ProBNP regularly may improve this. ProBNP levels in nursing home patients are probably not seriously biased by patient weight, age and renal function at levels above 225 pmol/L.

Acknowledgements

All 24 medical students from the Faculty of Medicine and Dentistry at the University of Bergen and personnel at the 7 participating nursing homes in Bergen. Dr Kjell-Harald Arntzen, Cardiologist. The study was funded by a grant from the Norwegian Research Council.

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