Association of Selected Antipsychotic Agents With Major Adverse Cardiovascular Events and Noncardiovascular Mortality in Elderly Persons

Sahlberg, Marie; Holm, Ellen; Gislason, Gunnar; Køber, Lars; Torp-Pedersen, Christian; Andersson, Charlotte

Published in:
Journal of the American Heart Association

DOI:
10.1161/JAHA.114.001666

Publication date:
2015

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal?

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Association of Selected Antipsychotic Agents With Major Adverse Cardiovascular Events and Noncardiovascular Mortality in Elderly Persons

Marie Sahlberg, MD; Ellen Holm, MD;* Gunnar H. Gislason, MD, PhD; Lars Køber, MD, Dsc; Christian Torp-Pedersen, MD, DSc; Charlotte Andersson, MD, PhD*

Background—Data from observational studies have raised concerns about the safety of treatment with antipsychotic agents (APs) in elderly patients with dementia, but this area has been insufficiently investigated. We performed a head-to-head comparison of the risk of major adverse cardiovascular events and noncardiovascular mortality associated with individual APs (ziprasidone, olanzapine, risperidone, quetiapine, levomepromazine, chlorprothixen, flupentixol, and haloperidol) in Danish treatment-naive patients aged ≥70 years.

Methods and Results—We followed all treatment-naive Danish citizens aged ≥70 years that initiated treatment with APs for the first time between 1997 and 2011 (n = 91,774, mean age 82 ±7 years, 35,474 [39%] were men). Incidence rate ratios associated with use of different APs were assessed by multivariable time-dependent Poisson regression models. For the first 30 days of treatment, compared with risperidone, incidence rate ratios of major adverse cardiovascular events were higher with use of levomepromazine (3.80, 95% CI 3.43 to 4.21) and haloperidol (1.85, 95% CI 1.67 to 2.05) and lower for treatment with flupentixol (0.54, 95% CI 0.45 to 0.66), ziprasidone (0.31, 95% CI 0.10 to 0.97), chlorprothixen (0.76, 95% CI 0.61 to 0.95), and quetiapine (0.68, 95% CI 0.58 to 0.80). Relationships were generally similar for long-term treatment. The majority of agents were associated with higher risks among patients with cardiovascular disease compared with patients without cardiovascular disease (P for interaction <0.0001). Similar results were observed for noncardiovascular mortality, although differences in associations between patients with and without cardiovascular disease were small.

Conclusions—Our study suggested some diversity in risks associated with individual APs but no systematic difference between first- and second-generation APs. Randomized placebo-controlled studies are warranted to confirm our findings and to identify the safest agents. (J Am Heart Assoc. 2015;4:e001666 doi: 10.1161/JAHA.114.001666)

Key Words: antipsychotic medications • cardiovascular risks • elderly
dementia are often prescribed APs for conditions such as anxiety, depression, or insomnia; however, the outcomes associated with AP use in this particular group have not been well investigated, and it is not known if risks differ for patients with and without dementia. Moreover, several APs are considered to pose greater risk of adverse outcomes for patients with established cardiovascular disease (CVD) than for patients without CVD, but head-to-head comparisons of individual APs in patients with and without CVD are sparse. To further address these issues, we investigated the risk of major adverse cardiovascular events (MACE) and noncardiovascular mortality associated with individual APs in a Danish population with and without diagnosed dementia and with and without CVD.

Methods

The study was approved by the Danish Data Protection Agency (2007-58-0015/local j.nr. GEH-2014-012 I-Suite nr: 02720). Register-based studies in which persons cannot be identified do not need ethics approval in Denmark. All Danish citizens are medically covered by a tax-financed system that provides each citizen with equal health care free of copayment. For administrative purposes, the government has kept records of all hospitalizations (in-hospital and outpatient visits) since 1978 (in the Danish National Patient Registry) and records of all prescription claims from Danish pharmacies since 1995 (in the Danish Register of Medicinal Product Statistics). Furthermore, registration of all births and deaths, including dates of occurrence, has been complete for all citizens since 1968 (in the National Population Register). Because all Danish citizens are given a permanent personal civil registration number at time of birth or immigration, they can be followed up by individual-level linkage of the registers.

Population and Comorbidities

For the present study, we included all persons in Denmark between 1997 and 2011 who were aged ≥70 years at the time when they claimed their first prescription of antipsychotic medication and who had previously been treatment-naïve (ie, allowing for a look back to 1995, when the Danish Register of Medicinal Product Statistics was established). We identified comorbidities throughout the whole observational period by continuous screening of the Danish National Patient Register. Because most diagnoses were for chronic conditions, people were classified as having the disease from the first day of diagnosis. For all diagnoses but dementia, schizophrenia, and Parkinson’s disease, only validated in-hospital diagnoses were considered. In addition to previously validated chronic comorbid diagnoses, we retrieved information on acute delirium based on in-hospital diagnoses. Because the diagnoses of dementia, Parkinson’s disease, and schizophrenia are often based on outpatient visits, diagnoses from both in-hospital and outpatient visits were considered for these comorbidities.

Outcomes

The primary outcomes were MACE, comprising the first occurring nonfatal acute myocardial infarction (International Classification of Diseases, 10th revision [ICD-10] code I21) or nonfatal ischemic stroke (ICD-10 codes I63 and I64 [“I64” denotes unspecified stroke, of which the majority are of ischemic origin]) and cardiovascular mortality (ICD-10 codes I00 to I19) and non–cardiovascular-related mortality (causes of mortality were obtained from the Danish Causes of Death Register).

Pharmacotherapy

From the National Register of Medicinal Product Statistics, we identified exposure to the individual APs outlined in Table 1. For these agents and for vitamin K antagonists (B01AA03), clopidogrel (B01AC04), low-dose aspirin (B01AC06), and loop diuretics (C03CA01, C03CA02), treatment was updated continuously, that is, patients were considered to be exposed only while covered by claimed prescriptions. To determine treatment length and average daily dosages, up to 3 consecutive prescriptions were considered in a retrospective manner. We created an algorithm for each agent in which minimum, maximum, and typical daily dosages of used medication were defined. For patients’ first claimed prescriptions, the typical daily dosage was assigned, and treatment length was calculated by dividing the amount of claimed medications by that daily dosage. For patients who were covered by a previous prescription at the time of claiming a new prescription, the daily dosage was reset, and a new daily dosage was calculated as the amount of claimed medications during the previous period divided by time between prescription claims (based on up to 3 previous prescriptions without treatment breaks). If calculated dosages exceeded the predefined highest daily dosages, patients were assigned the maximum dosages, and exceeding tablets were assumed to be stored and consumed during the immediate period following the end of the last prescription.

For other medications (ie, dementia medications [ATC code N06DA], beta blockers [C07], thiazides [C03A], calcium channel blockers [C08], digoxin [C01AA], renin-angiotensin system inhibitors [C09], aldosterone blockers [C03D], and statins [C10AA]), treatment status was updated every 30 days for the whole observational period. Persons were considered to be in treatment with the different medications if
they claimed at least 1 prescription during the preceding 4 months (this pragmatic method was applied because of computational limitations).

Statistics
All patients were followed from the date of first claimed prescription until date of death, emigration, or December 31, 2011. The incidence rate ratios (IRRs) associated with exposure to APs were analyzed using multivariable Poisson regression models. The following variables were included as time-dependent variables: treatment with antipsychotic medications; all comorbidities (schizophrenia, Parkinson’s disease, dementia, acute delirium, prior cerebrovascular disease, heart failure, acute myocardial infarction, peripheral vascular disease, chronic obstructive pulmonary disease, atrial fibrillation, moderate or severe renal disease, diabetes, cancer, and cancer with metastases; for ICD-10 codes, see Table 2); age; and use of warfarin, aspirin, clopidogrel, loop diuretics, thiazides, renin-angiotensin system blockers, aldosterone antagonists, statins, beta blockers, calcium channel blockers, or digoxin. All models were adjusted for the aforementioned variables and for actual calendar year and sex. Use of antipsychotic medications was included as a time-dependent multilevel categorical variable for which people using >1 medication for a given time were grouped in a separate use of multiple medication category. People who were not covered by a claimed prescription were assigned to a no treatment category. For all comparisons, use of risperidone as monotherapy served as the referent group (because this group was the largest quantitatively). We performed 2 separate types of analyses. In the first, we created 3 different categorical variables for antipsychotic use according to time elapsed since first treatment because time dependency for risks was present ($P$ for interaction between time elapsed and associated risks <0.0001; use of medications was split into the first 30 days, 31 to 365 days, and >365 days after treatment initiation). After having explored the IRRs among different medications in different time periods, the differences appeared to be rather small between the periods; therefore, in subsequent models, we included a variable reflecting only

Table 1. Classification of the Different Antipsychotic Agents

<table>
<thead>
<tr>
<th>Name</th>
<th>ATC Code</th>
<th>Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorprothixen</td>
<td>N05AF03</td>
<td>First</td>
</tr>
<tr>
<td>Flupentixol</td>
<td>N05AF01</td>
<td>First</td>
</tr>
<tr>
<td>Haloperidol</td>
<td>N05AD01</td>
<td>First</td>
</tr>
<tr>
<td>Levomepromazine</td>
<td>N05AA02</td>
<td>First</td>
</tr>
<tr>
<td>Olanzapine</td>
<td>N05AH03</td>
<td>Second</td>
</tr>
<tr>
<td>Risperidone</td>
<td>N05AX08</td>
<td>Second</td>
</tr>
<tr>
<td>Quetiapine</td>
<td>N05AH04</td>
<td>Second</td>
</tr>
<tr>
<td>Ziprasidone</td>
<td>N05AE04</td>
<td>Second</td>
</tr>
</tbody>
</table>

Table 2. ICD-10 Codes for Various Medical Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>ICD-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dementia</td>
<td>F00, F01, F02, F03, F05.1, G30</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>F20</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>G20</td>
</tr>
<tr>
<td>Acute delirium</td>
<td>F05</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>I20, I23, I24, I25</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>I60 to I69, G45, G46</td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
<td>I21, I22, I23</td>
</tr>
<tr>
<td>Heart failure</td>
<td>I50, I42, I110, I13.0, I13.2</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>I48</td>
</tr>
<tr>
<td>Peripheral artery disease</td>
<td>I70 to I74</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>J40 to 47, J60 to 67, J68.4, J70.1, J70.3, J84.1, J92.0, J96.1, J98.2, J98.3</td>
</tr>
<tr>
<td>Cancer</td>
<td>C00 to C75, C81 to 96</td>
</tr>
<tr>
<td>Metastases</td>
<td>C76 to C80</td>
</tr>
<tr>
<td>Renal disease</td>
<td>N00 to 06, N07, N11, N17 to 19, R34, I12, I13, Q61</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Treatment with glucose-lowering medication (ATC code A10)</td>
</tr>
</tbody>
</table>

ICD-10 indicates International Classification of Diseases, 10th Revision.
time since first treatment initiation to account for time dependency in risks. In the second models, we tested for effect modification between the different treatment groups and prevalent dementia (diagnosis or use of dementia medications) and CVD (myocardial infarction, congestive heart failure, stroke, or peripheral vascular disease) by inclusion of an interaction term between the categorical treatment variable and CVD or dementia, respectively. Because these were highly significant, we created a categorical dummy variable stratifying use of medications by the prevalence of the different diseases. All analyses were done in SAS version 9.4 (SAS Institute). A 2-sided \( P<0.05 \) was considered statistically significant.

## Results

We identified 91,774 persons (mean age 82±7 years, 35,474 [39%] were men). Numbers of those ever exposed to the different APs are presented in Table 3, along with the baseline characteristics for different exposure groups. The different exposure groups had comparable age, sex, and comorbidity burdens, although patients receiving levomepro-
mazine and haloperidol had higher prevalence of cancers (≈30% versus 10% for the other groups).

Total exposure time, MACE, and noncardiovascular mortality for each treatment group are given in Tables 4 and 5. Crude event rates were lowest for flupentixol and chlorprothixen compared with the other AP groups. As seen in the tables, for all agents, we observed a highly increased incidence rate of MACE and noncardiovascular mortality during the first month after initiation, with a subsequent decline for longer treatment durations. Associated adjusted IRRs were increased for treatment with levomepromazine or haloperidol and treatment with multiple medications, whereas treatment with flupentixol, ziprasidone, chlorprothixen, or quetiapine was associated with a significantly lower IRR compared with treatment with risperidone, as shown in Figure 1 (MACE) and Figure 2 (noncardiovascular mortality). For longer treatment duration, levomepromazine and use of multiple medications were no longer associated with increased risks compared with risperidone monotherapy (Figures 1C and 2C). The risks associated with use of different antipsychotic medications differed for

### Table 4. Numbers of Major Adverse Cardiovascular Events, Exposure Time, and Crude Incidence Rates for Different Antipsychotic Agents

<table>
<thead>
<tr>
<th>Associated risks for the first 30 days after initiation</th>
<th>Events/Person-Years</th>
<th>Unadjusted Incidence Rate (Per 100 Person-Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risperidone</td>
<td>842/1765</td>
<td>47.7 (44.6 to 51.0)</td>
</tr>
<tr>
<td>Flupentixol</td>
<td>142/659</td>
<td>16.5 (14.0 to 19.5)</td>
</tr>
<tr>
<td>Chlorprothixen</td>
<td>132/460</td>
<td>28.7 (24.2 to 34.0)</td>
</tr>
<tr>
<td>Levomepromazine</td>
<td>1162/717</td>
<td>162 (153 to 172)</td>
</tr>
<tr>
<td>Haloperidol</td>
<td>1250/1340</td>
<td>93.3 (88.3 to 98.6)</td>
</tr>
<tr>
<td>Ziprasidone</td>
<td>3/30</td>
<td>10.1 (3.2 to 31.2)</td>
</tr>
<tr>
<td>Quetiapine</td>
<td>284/952</td>
<td>29.8 (26.5 to 33.5)</td>
</tr>
<tr>
<td>Olanzapine</td>
<td>428/1106</td>
<td>38.7 (35.2 to 42.5)</td>
</tr>
<tr>
<td>Multiple medications</td>
<td>143/142</td>
<td>101 (85 to 119)</td>
</tr>
</tbody>
</table>

### Table 5. Numbers of Noncardiovascular Mortality, Exposure Time, and Crude Incidence Rates for Different Antipsychotic Agents

<table>
<thead>
<tr>
<th>Associated risks for the first 30 days after initiation</th>
<th>Events/Person-Years</th>
<th>Unadjusted Incidence Rate (Per 100 Person-Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risperidone</td>
<td>630/1809</td>
<td>34.8 (32.2 to 37.7)</td>
</tr>
<tr>
<td>Flupentixol</td>
<td>99/867</td>
<td>11.4 (9.4 to 13.9)</td>
</tr>
<tr>
<td>Chlorprothixen</td>
<td>116/469</td>
<td>24.8 (20.6 to 29.7)</td>
</tr>
<tr>
<td>Levomepromazine</td>
<td>2052/750</td>
<td>274 (262 to 286)</td>
</tr>
<tr>
<td>Haloperidol</td>
<td>2365/1411</td>
<td>168 (161 to 175)</td>
</tr>
<tr>
<td>Ziprasidone</td>
<td>12/31</td>
<td>39.1 (22.2 to 68.8)</td>
</tr>
<tr>
<td>Quetiapine</td>
<td>281/982</td>
<td>28.6 (25.5 to 32.2)</td>
</tr>
<tr>
<td>Olanzapine</td>
<td>472/1136</td>
<td>41.6 (38.0 to 45.5)</td>
</tr>
<tr>
<td>Multiple medications</td>
<td>239/148</td>
<td>162 (143 to 184)</td>
</tr>
</tbody>
</table>
Figure 1. Multivariable-adjusted risks of MACE for different treatment regimens in different time periods after treatment initiation: (A) first 30 days, (B) 31 to 365 days, (C) >365 days. MACE indicates major adverse cardiovascular events.
Figure 2. Multivariable-adjusted risks of noncardiovascular mortality for different treatment regimens in different time periods after treatment initiation: (A) first 30 days, (B) 31 to 365 days, (C) >365 days.
patients with and without CVD and were greater among patients with established CVD (P for interaction between treatment group and CVD < 0.00001) (Figure 3). Similarly, the risks were slightly higher among patients without established dementia compared with patients with dementia (P for interaction between treatment group and dementia < 0.0001) (Figure 4).

**Discussion**

In this Danish study of all persons without prior use of APs who were aged ≥ 70 years, we investigated the association between different APs and risks of MACE and noncardiovascular mortality. In general, we observed that use of haloperidol or levomepromazine and treatment with multiple medications were associated with similar or greater IRRs than use of risperidone, whereas treatment with flupentixol, ziprasidone, chlorprothixen, or quetiapine was associated with significantly lower IRRs compared with treatment with risperidone. The absolute event rates were highest shortly after treatment initiation and declined with long-term use.

**Safety of APs in Elderly Persons**

After findings of increased risk of cerebrovascular events associated with use of second-generation APs, the US Food and Drug Administration (FDA) issued a warning in 2005.

---

**Figure 3.** Multivariable-adjusted risks of (A) MACE and (B) noncardiovascular mortality stratified by prevalent CVD. CV indicates cardiovascular; CVD, cardiovascular disease; MACE, major adverse cardiovascular events.
against use of second-generation APs in dementia. In 2008, the FDA extended this warning to include use of first-generation APs in dementia. Several studies have since demonstrated increased mortality with use of APs in dementia, and some studies have shown increased mortality in elderly patients regardless of dementia status. Previous studies have also suggested that the use of APs is associated with increased risk of myocardial infarction among older patients with treated dementia and that exposure to APs may be a trigger for stroke. Furthermore, a Cochrane review estimated the risk of cerebrovascular events to be >3-fold higher in risperidone-versus placebo-treated elderly patients with dementia. Our observations suggest that medications belonging to the second- and first-generation classes of APs may be associated with more or less comparable risk in elderly patients with or without dementia, although flupenthixol, chlorprothixen, and quetiapine may be particularly associated with lower MACE and mortality rates than risperidone.

Figure 4. Multivariable-adjusted risks of (A) MACE and (B) noncardiovascular mortality stratified by prevalent dementia. CV indicates cardiovascular; MACE, major adverse cardiovascular events.
30 days of treatment and declined with longer exposure time. This finding is consistent with the findings of other studies.\textsuperscript{11,22,24} When elderly patients are prescribed APs, it may be due to neuropsychiatric symptoms in dementia or to delirium as part of a somatic disease that carries a high mortality risk. Because we were unable to accurately control for several diseases in our study, it cannot be excluded that the higher risks observed, especially among nondemented elderly people who were treated, may be partly due to confounding by indication. Delirium, however, is an acute disease with high short-term mortality; therefore, associations with long-term use may be less prone to confounding than the analyses of short-term use. Worth emphasizing in this context is that the relative risk of mortality with levomepromazine and haloperidol shortly after treatment initiation was higher than that observed for other APs. A very high proportion of patients using these drugs had diagnosed cancer; therefore, we cannot rule out that the IRR for the first period after treatment initiation was driven by confounding by indication. Even when excluding patients with a preexisting cancer, haloperidol has been shown to be associated with the highest risk of death among APs users in nursing homes.\textsuperscript{24}

First- Versus Second-Generation APs

Second-generation APs have been promoted for having a low risk of extrapyramidal symptoms compared with first-generation APs. Previous studies suggest that both first- and second-generation APs can lower blood pressure, leading to increased risk of falls and to a varying extent to prolonged QT interval, which might lead to arrhythmia and death.\textsuperscript{25–28} Another problem related to second-generation APs is adverse influence on glucose metabolism, diabetes, and blood lipid composition, leading to increased cardiovascular risks with long-term use.\textsuperscript{29,30}

Several prior observational studies have compared the safety of first- versus second-generation APs\textsuperscript{5,6,8,9,11,19,22,31–33} and generally have indicated that the risk of death and/or MACE when using second-generation APs is at least as high as that for first-generation APs.\textsuperscript{21} At least 1 retrospective cohort study has suggested that in older adults with dementia, second- and first-generation APs were associated with comparable risks of ischemic stroke.\textsuperscript{31} A larger retrospective cohort study in 2009 also suggested a comparable dose-related increased risk of sudden cardiac death for first- and second-generation APs.\textsuperscript{12}

Strengths and Limitations of the Study

The main strength and novelty of this study is that we compared MACE and noncardiovascular mortality risk among individual APs across the first and second generations in a rather large group of patients aged \( \geq 70\) years. Moreover, because medical care is offered to all Danish citizens without copayment and because medications are reimbursed by the government, selection bias related to socioeconomic status and, for example, prior participation in the labor market is likely less pronounced compared with many other observational studies. Another strength of our study was the sample size, which allowed us to examine the effect of individual drugs, although it must be acknowledged that we might still have lacked power to firmly conclude anything about some of the individual drugs (particularly ziprasidone). Some limitations, however, merit consideration. We lacked data on several clinical variables including blood pressure, hematological profiles, electrocardiograms, and indication for treatment. All of these variables may have influenced clinicians’ decisions of whether to prescribe a particular agent. Our data must be interpreted with great caution, bearing these limitations in mind.

Conclusion and Clinical Implications

There is an important but limited role for antipsychotic treatment of severe neuropsychiatric symptoms.\textsuperscript{23} Our study demonstrated high incidence rates of MACE and noncardiovascular mortality associated with use of individual APs in elderly persons with or without dementia and with and without CVD. This underscores that APs should be used with caution in elderly patients, regardless of dementia status, at the lowest possible dose and for shortest possible time. A particular focus on risks and benefits is warranted among people with prevalent CVD because these patients seem to have the highest risks associated with APs. Our study further suggested some diversity in risks associated with individual APs but no systematic differences between first- and second-generation APs. Randomized placebo-controlled studies are warranted to confirm our findings and to identify the safest agents. Until then, the antipsychotic benefit in people with and without dementia must be considered against the risks of adverse events. Finally, in Denmark, restrictions on the use of APs are focused predominantly on people with dementia. Our study warrants a broader focus on elderly people in general.

Acknowledgments

Author Contributions: Andersson had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Sahlberg, Holm, Andersson. Acquisition of data: Torp-Pedersen, Gislason, Køber. Analysis and interpretation of data: All authors. Drafting of the manuscript: Sahlberg, Holm. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Andersson. Study supervision: Holm, Andersson.
Sources of Funding
Dr Andersson was funded by an independent research grant from the Danish Agency for Science, Technology and Innovation (grant number FSS-11-120873). Dr Gislason is supported by an independent research scholarship from the Novo Nordisk Foundation. None of the funding sources had any influence on design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

Disclosures
Sahlberg (none), Holm (none), Gislason (none), Torp-Pedersen (reports grants and personal fees from Cardiome, grants and personal fees from Merck, grants and personal fees from Sanofi, grants and personal fees from Daiichi, grants from BMS, outside the submitted work), Kober (none), Andersson (reports grants from Danish agency for science, technology and innovation, grants from AstraZeneca, during the conduct of the study).

References
Association of Selected Antipsychotic Agents With Major Adverse Cardiovascular Events and Noncardiovascular Mortality in Elderly Persons
Marie Sahlberg, Ellen Holm, Gunnar H. Gisason, Lars Køber, Christian Torp-Pedersen and Charlotte Andersson

_J Am Heart Assoc._ 2015;4:e001666; originally published September 1, 2015;
doi: 10.1161/JAHA.114.001666

The _Journal of the American Heart Association_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Online ISSN: 2047-9980

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://jaha.ahajournals.org/content/4/9/e001666