

Original article

Comparative Study of Ambient Air Particles in Patients Hospitalized for Heart Failure and Acute Coronary Syndrome

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ABSTRACT

Introduction and objectives: Currently air pollution is considered as an emerging risk factor for cardiovascular disease. Our objective was to study the concentrations of particulate matter in ambient air and analyze their relationship with cardiovascular risk factors in patients admitted to a cardiology department of a tertiary hospital with the diagnosis of heart failure or acute coronary syndrome (ACS).

Methods: We analyzed 3950 consecutive patients admitted with the diagnosis of heart failure or ACS. We determined the average concentrations of different sizes of particulate matter (<10, <2.5, and <1 μm and ultrafine particles) from 1 day or up to 7 days prior to admission (1 to 7 days lag time).

Results: There were no statistically significant differences in mean concentrations of particulate matter <10, <2.5 and <1 μm in size in both populations. When comparing the concentrations of ultrafine particles of patients admitted due to heart failure and acute coronary syndrome, it was observed that the former had a tendency to have higher values (19 845.35±8 806.49 vs 16 854.97 ± 8005.54 cm⁻³, P<.001). The multivariate analysis showed that ultrafine particles are a risk factor for admission for heart failure, after controlling for other cardiovascular risk factors (odds ratio = 1.4; confidence interval 95%, from 1.15 to 1.66 P = .02).

Conclusions: In our study population, compared with patients with ACS, exposure to ultrafine particles is a precipitating factor for admission for heart failure.

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Estudio comparativo de las partículas en aire ambiente en pacientes ingresados por insuficiencia cardíaca y síndrome coronario agudo

RESUMEN

Introducción y objetivos: Actualmente se considera la contaminación atmosférica como un factor de riesgo emergente de enfermedades cardiovasculares. Nuestro objetivo fue comparar las concentraciones de partículas atmosféricas en aire ambiente y analizar su relación con los factores de riesgo cardiovascular en pacientes que ingresan en un servicio de cardiología de un hospital terciario con el diagnóstico de insuficiencia cardíaca y síndrome coronario agudo (SCA).

Métodos: Analizamos a un total de 3.950 pacientes ingresados de forma consecutiva con el diagnóstico de insuficiencia cardíaca y SCA. Se determinaron las concentraciones medias de material particulado con tamaño < 10, 2,5 y 1 μm y partículas ultrafinas, desde el día anterior hasta los 7 días previos al ingreso (1 a 7 días de retardo).

Resultados: No se observaron diferencias estadísticamente significativas en las concentraciones medias de material particulado con tamaño < 10, 2,5 y 1 μm en ambos grupos de población. Cuando se compararon las concentraciones de partículas ultrafinas de los pacientes ingresados por insuficiencia cardíaca y SCA, se observó que los primeros tenían tendencia a valores más altos (19.845,35 ± 8.806,49 frente a 16.854,97 ± 8.005,54/cm⁻³; p < 0,001). El análisis multivariable muestra que las partículas ultrafinas son un factor de riesgo para ingresar por insuficiencia cardíaca, tras controlar por los distintos factores de riesgo cardiovascular (odds ratio = 1,4; intervalo de confianza del 95%, 1,15-1,66; p = 0,02).

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Conclusiones: En nuestra población de estudio, comparada con pacientes con SCA, la exposición a partículas ultrafinas constituye un factor precipitante del ingreso por insuficiencia cardiaca.
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Abbreviations

ACS: acute coronary syndrome
AMI: acute myocardial infarction
NSTEMI: non-ST-elevation myocardial infarction
PM: particulate matter
STEMI: ST-elevation myocardial infarction

INTRODUCTION

Cardiovascular diseases are the leading cause of death in Spain. Ischemic heart disease and heart failure are the main causes of cardiovascular deaths.^{1–3}

The main risk factors related to the development of cardiovascular diseases are tobacco smoking, diabetes mellitus, high blood pressure, and dyslipidemia.⁴ It is well-known that the risk of cardiovascular diseases multiplies if several of these factors are present. In Spain, 31% of individuals seen in primary health care have 2 risk factors and around 6% have 3.⁵ Atmospheric pollution and cardiovascular risk was recently presented as one of the key themes in the *XIV Simposio Internacional de Cardiopatía Isquémica* (14th International Meeting on Ischemic Heart Disease) organized in Girona, Spain, by the Department of Ischemic Heart Disease and Coronary Care Units of the *Sociedad Española de Cardiología* (Spanish Society of Cardiology) in April 2010. Atmospheric pollution was considered to be an emerging risk factor for ischemic heart disease.

The impact that atmospheric pollution has on health has been discussed since the middle of the 20th century. The large number of epidemiological and experimental studies shows that there has been a renewed interest in this subject. These have stated since 1990 that pollution levels that may be considered normal in developed countries are still a health risk.^{6,7} In the last few years, several multicenter studies have assessed the situation in different regions of the world, such as the APHEA study in Europe,^{8–10} the NMMAPS in the United States,¹¹ or national European projects such as *Air & Santé* in France¹² or MISA in Italy.¹³ The EMECAS (*Estudio Multicéntrico Español sobre la relación entre Contaminación Atmosférica y Salud*) project included 16 Spanish cities and analyzed the relationship between atmospheric pollution and health.^{14–16} These studies investigated the acute or short-term (on the same day or subsequent days) effects of an increase in pollution and concluded that for every daily 10 $\mu\text{g}/\text{m}^3$ increase in the concentration of suspended particles smaller than 10 μm (breathable), the number of people who die in the days immediately following increases by about 0.7%.⁶

The aim of this study was to test the concentrations of atmospheric particles in ambient air and to analyze their relationship with cardiovascular risk factors in patients admitted to a tertiary hospital's Department of Cardiology with a diagnosis of heart failure and acute coronary syndrome (ACS).

METHODS

Population

We analyzed 3950 patients admitted consecutively to our hospital from October 2006 to December 2009 with a diagnosis of heart failure and ACS. Only patients who complied with all the inclusion criteria and none of the exclusion criteria were considered for inclusion. The presence of viral or bacterial infection 15 days before admission was one of the exclusion criteria.

The inclusion criteria for patients with heart failure were: a) patients who survived admission to hospital for suspected heart failure and which was confirmed as the primary diagnosis on discharge, and b) who complied with the European Society of Cardiology's diagnostic regulations: symptoms compatible with heart failure according to the Framingham criteria and evidence of heart dysfunction by echocardiogram, isotopic ventriculography, or cardiac catheterization.¹⁷ The following were considered as criteria for exclusion: a) patient admitted to hospital for heart failure which was confirmed as the secondary diagnosis on discharge; b) heart failure secondary to serious heart valve diseases requiring surgery or secondary to chronic *pulmonary* heart disease; c) concomitant diseases with a survival prognosis of <12 months, and d) patients who died of heart failure in hospital.¹⁸

The inclusion criteria for patients with ACS^{19,20} were: patients who survived admission to hospital for suspected acute myocardial infarction (AMI) with ST-elevation (STEMI) and non-ST-elevation ACS, and non-ST-elevation AMI (NSTEMI) confirmed as the primary diagnosis on discharge. The following were considered as criteria for exclusion: a) patients admitted to hospital for ACS, confirmed as the secondary diagnosis at discharge; b) concomitant diseases with a survival prognosis of <12 months, and c) patients who died of ACS in hospital.²¹

STEMI was defined by the presence of compatible symptoms, persistent (>20 min) ST-segment elevation ≥ 1 mm in at least 2 contiguous leads or the presence of left bundle branch block presumed to be a new occurrence, and elevated cardiac troponin-I ≥ 0.5 ng/ml (cut-off point ≥ 0.5 ng/ml for the diagnosis of AMI; immunological reagents of the Orthoclinical Diagnostics Vitros 5100 system, United States). NSTEMI was defined by the presence of compatible symptoms, cardiac troponin-I ≥ 0.5 ng/ml and/or dynamic ST-segment changes (≥ 1 mm decrease in the ST-segment or non-persistent elevation in at least 2 contiguous leads). Unstable angina was defined by the presence of suggestive chest pain with or without re-polarization abnormalities in the baseline electrocardiogram. Serum levels of cardiac troponin-I had to be <0.5 ng/ml 24 h after the appearance of symptoms.

The study was approved by our hospital's clinical research ethics committee and all the patients signed an informed consent.

Baseline Variables on Admission

We studied age (years), sex, tobacco smoking (smokers and non-smokers), hypercholesterolemia (cut-off point, 250 mg/dl), hypercholesterolemia drug treatment, arterial hypertension (hypertensive patients, which included those taking hypertensive drugs, and non-hypertensive patients), hypertensive drug treatment,

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