

Meta Analysis

Main air pollutants and ventricular arrhythmias in patients with implantable cardioverter-defibrillators: A systematic review and meta-analysis

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Abstract

Objective: Previous studies of ambient air pollutants and ventricular arrhythmias in patients with implantable cardioverter-defibrillator (ICD) have yielded mixed results, and the association between air pollution and ventricular arrhythmias in these patients remains unclear. This study aimed to assess and quantify the association between exposure to major air pollutants [CO, inhalable particles (PM₁₀), SO₂, fine particulate matter (PM_{2.5}), O₃, and NO₂] and the presence of ventricular arrhythmia in patients with ICD.

Methods: The Medline, PubMed, Web of Science, Global Health Library, Virtual Health Library, Population Information Online (POPLINE), and New York Academy of Medicine Grey Literature Report databases were searched to identify studies analyzing the association between ventricular arrhythmias in patients with ICD and the abovementioned main air pollutants. Pooled estimates were generated using a random-effects model or fixed-effects model, according to the value of heterogeneity. Heterogeneity within studies was assessed using Cochran's *Q* and *I*² statistics. Funnel plots, Egger's regression test, and Begg's rank correlation method were used to evaluate publication bias. Sensitivity analyses were also conducted to evaluate the potential sources of heterogeneity.

Results: After a detailed screening of 167 studies, seven separate studies were identified. Ventricular arrhythmias in patients with ICD were found to be positively, but not significantly, associated with CO, PM₁₀, SO₂, PM_{2.5}, and NO₂, with a pooled estimate [odds ratio (OR) associated with each 10 µg/m³ increase in pollutant concentration, except for CO, which was associated with each 1 mg/m³ increase in concentration] of 1.03 [95% confidence interval (CI): 0.92–1.17, *P* = 0.59] for CO, 1.01 (95%CI: 0.97–1.05, *P* = 0.55) for PM₁₀, 1.09 (95%CI: 0.95–1.24, *P* = 0.22) for SO₂, 1.07 (95%CI: 0.95–1.21, *P* = 0.25) for PM_{2.5}, and 1.06 (95%CI:

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0.98–1.14, $P = 0.16$) for NO_2 . No increased risk of ventricular arrhythmias in patients with ICD was found to be associated with O_3 ($OR = 1.00$; 95% CI : 0.98–1.01, $P = 0.56$).

Conclusions: The results of this study provide little evidence that ambient air pollutants affect the risk of ICD discharges for treating ventricular arrhythmias.

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Keywords: Air pollutants; Ventricular arrhythmia; Implantable cardioverter-defibrillator; Systematic review

Introduction

Air pollution has been linked to the overall mortality in epidemiological investigations,^{1–3} and most pieces of evidence consider an increased cardiovascular disease incidence as a primary driver.^{4–6} The risk of adverse events seems to be increased in certain populations, including those with underlying health conditions, such as diabetes, chronic obstructive pulmonary disease, congestive heart failure, previous arrhythmia, and hypertension.^{7–11}

Implantable cardioverter-defibrillators (ICDs) are designed to detect/treat life-threatening ventricular arrhythmias. These devices are implanted under the skin and their electrodes are attached transvenously to the heart, where they monitor heart rhythm. On detecting a ventricular rate above a programmed value, they can initiate pacing and/or shock therapy to restore normal rhythm. The electrogram; beat-to-beat intervals immediately before, during, and after the event; and date/time of each event are recorded by the ICD and regularly downloaded during clinical follow-up. This feature makes an ICD a useful tool in investigating associations between acute air pollution exposures and incidence of ventricular arrhythmias.¹²

Several studies have demonstrated associations between air pollution and ventricular arrhythmias in patients with ICD. However, the association between air pollution and near-term risk of ventricular arrhythmias in patients with ICD remains controversial. Some studies have shown an association,^{13,14} while other studies have found either no association^{15–17} or an association only for selected pollutants.^{18,19}

To our knowledge, a comprehensive and systematic meta-analysis of studies published in any language investigating the association between ambient air pollutants and ventricular arrhythmias in patients with ICD has not been performed. This report presents such a systematic review and meta-analysis.

Methods

Search strategy

Databases including Medline, PubMed, Web of Science, Global Health Library, Virtual Health Library, Population Information Online (POPLINE), and New York Academy of Medicine Grey Literature Report, were searched using individual/combinations of the following keywords: “air pollutants” OR “air pollution” OR “environmental exposure” OR “particulate matter” OR “particles” OR “particle” OR “soot” OR “ PM_{10} ” OR “ $\text{PM}(10)$ ” OR “ $\text{PM}_{2.5}$ ” OR “ $\text{PM}(2.5)$ ” OR “sulfur dioxide” OR “sulphur dioxide” OR “ SO_2 ” OR “ $\text{SO}(2)$ ” OR “nitrogen dioxide” OR “nitrogen oxides” OR “ NO_2 ” OR “ $\text{NO}(2)$ ” OR “carbon monoxide” OR “elemental carbon” OR “CO” OR “ozone” OR “ O_3 ” OR “O (3)” AND “implantable cardioverter-defibrillator” OR “ICD” AND “ventricular arrhythmia” OR “arrhythmia”. Searches were limited to studies published from 1948 to June 31, 2017. The reference lists of the included studies and relevant reviews were also manually searched to identify remaining studies.

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) study design: case-crossover and time series studies; (2) participants: patients with ICD; (3) ventricular arrhythmias detected in patients using ICD; (4) studies presenting original data for gaseous pollutants (i.e., CO, SO_2 , NO_2 , and O_3) or particulate pollutants (i.e., $\text{PM}_{2.5}$ or PM_{10}); and (5) all studies that reported associations between ventricular arrhythmias and air pollutant concentrations lagged 0–7 days. Studies published in English were also included. The exclusion criteria were as follows: (1) animal experiments, case reports, commentaries, and multiple papers from the same study; (2) studies with no original data; and (3) for studies without enough quantitative data, the

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