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Original Contribution

Air pollution and activation of mobile medical team for out-of-hospital cardiac arrest☆,☆☆

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ABSTRACT

Background: The association between air pollution exposure and cardiovascular events is well established, and the effect of short-term exposure on out-of-hospital cardiac arrest (OHCA) has received some attention. The effect of air pollution exposure and the activation of mobile intensive care units (MICUs) for cardiac arrest have never been studied.
Objective: We analyzed associations between air pollutants and MICU activation for OHCA.
Method: This is a retrospective study including 4558 patients with OHCA and MICU activation from 2007 to 2012. A time-stratified case crossover design was used. Particulate matter (PM) of median aerodynamic diameter less than 2.5 μm (PM2.5), less than 10 μm, and ozone were the 3 main pollutants used to determine the effects of pollution exposure on the event.
Results: A daily average increase of 27.6 $\mu g/m^3$ in ozone was associated with an increase of MICU activation for OHCA the following day (odds ratio [OR], 1.13; 95% confidence interval [CI], 1.03-1.22). For women, a daily average increase of 27.6 $\mu g/m^3$ in ozone was associated with an increase of MICU activation for OHCA the following day (OR, 1.19; 95% CI, 1.01-1.37). An hourly average increase of 10.5 $\mu g/m^3$ in PM2.5 was associated with an increase of MICU activation for OHCA in the current hour (OR, 1.11; 95% CI, 1.02-1.19). For men, an increase in PM2.5 was associated with an increase in MICU activation for OHCA the current hour (OR, 1.10; 95% CI, 1.01-1.20). No association was found with PM of median aerodynamic diameter less than 10 μm.
Conclusion: An association was found between air pollution and MICU activation for OHCA (ozone and PM2.5)

1. Introduction

Cardiovascular disease is the leading cause of mortality in industrialized countries [1]. Cardiac arrest represents a significant public health problem in developed countries and incidence rates of sudden cardiac death ranging between 0.36 and 1.28 per 1000 habitants per year [2]. The World Health Organization [3] has estimated outdoor particulate matter (PM) to be the 13th leading cause of mortality worldwide and to be responsible for approximately 800 000 deaths/year.

A link has been established between air pollutant concentration (PM or ozone) before onset and an out-of-hospital cardiac arrest (OHCA) [4]. Particulate matter induces effects on cardiovascular health such as arrhythmias, atherosclerotic and ischemic events, and enhanced thrombosis and heart failure, which may lead to cardiac arrest [5].

Whenever an OHCA occurs in France, the bystander phones the emergency unit, and an ambulance and the mobile intensive care unit (MICU) are activated by the physician who receives the call.

This study examined the effects of short-term exposure to air pollution on the incidence of MICU activation for cardiac arrests. Particulate matter 2.5 (PM with aerodynamic diameter, <2.5 μm), PM10, and ozone were the pollutants studied.

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☆☆ We analyzed associations between air pollutants and mobile medical team activation for cardiac arrests. The results confirm the link between OHCA and air pollution, especially PM2.5 and ozone and indirectly the more frequent activation of MMT during the day or hours after an increase in pollution.
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2. Materials and methods

2.1. Setting

This study was a retrospective study concerning past medical events recorded in the emergency medical service (EMS) database in Bordeaux. We focused on events, which occurred in the department of Gironde over the 6-year period from 2007 to 2012. The Gironde department is 10 000 km^2 in surface area, and its population is 1.5 million.

In France, when an OHCA occurs, a bystander asks for help by phoning the emergency dispatch center (EDC). At the call dispatch center, the physician who works at the center guides him through the first aid and sends an ambulance and a medical intensive care unit (MICU). After each intervention, the physician in the MICU gives the diagnosis to the EMS physician who keyboards it into the patient's medical files.

In our area of study, medical mobile teams (MMTs) are located in 8 towns in the department, and a physician-staffed MMT is always deployed whenever an OHCA is suspected, along with the standard ambulance.

This study was approved by the Commission Nationale de l'Informatique et des Libertés, that is, the French data privacy regulatory agency. Because it was a retrospective study in overall population, an ethical review committee was not required.

2.2. Study population and data collection

The population included in the study was adults aged 18 years or older who had been the object of activation of the MICU for OHCA over the 6-year period from 2007 to 2012. Out-of-hospital cardiac arrest was defined by cardiac arrest on arrival of the MICU. The diagnosis is that given by the MMT, when he/she examines the patient. If the patient never had resuscitation, the diagnosis usually recorded was “death certificate,” and the patients were not included. Patients without resuscitation attempted by paramedics were excluded, and patients without cardiac arrest on arrival of the MICU were excluded. Over this period, 4558 cases of OHCA were recorded based on these criteria.

All data for the 6-year period were collected in the patient's medical file completed by the emergency physician. The database is located in the EMS call center. The time to OHCA was defined as the time taken for the EDC to receive a call from a bystander. In addition, the time and location of the event were recorded as were the sex and age of the subject.

2.3. Outcome

The outcome is cardiac arrest with presumptive cardiac etiology. The cardiac etiology is suspected, after a physician has reviewed the medical files. Physicians checked all the medical files, where the cardiac diagnosis was recorded. This information was collected by physicians who evaluated the records to categorize the presumptive etiology of cardiac arrest based on Utstein criteria [6]. In this system, an arrest is presumed to be of cardiac etiology, unless it is known or likely to have been caused by trauma, submersion, drug overdose, asphyxia, exsanguination, or any other noncardiac cause as best determined by the rescuers. We included only cardiac arrest for which the Utstein criteria were presumed and where resuscitation was attempted by prehospital paramedics.

2.4. Pollution measurement

The PM10, PM2.5, and ozone were chosen to be analyzed for 2 reasons. Some studies found that these pollutants seemed to increase the risk of cardiac arrest [7-10]. Furthermore, for these pollutants, the background level is representative of a large geographic area, contrary to nitrogen dioxide, which is a very local pollutant, varying widely from one point to another, even in a small area.

Pollutant concentration data were obtained by the association AIRAQ, which monitors the air quality in Aquitaine (France). During the study period, 3 monitors measured PM2.5, 4 measured PM10, and 8 measured ozone. All these monitors are located in Gironde. The data are sent every hour from the stations to the AIRAQ headquarters and integrated in a database belonging to AIRAQ. We had the hourly and daily averages of PM2.5, PM10, and ozone; and for ozone, we had the daily maximum 8-hour running mean and the daily maximum hour. All these averages were available for each station. An exposure indicator was established to reflect the pollution level in Gironde by calculating the arithmetic mean for each monitor measuring the pollutant (PM2.5 or PM10 or ozone), thereby providing a daily mean concentration for pollutants in Gironde. We chose to study hourly and daily effects because exposure to pollutants over a few hours to few days can trigger various cardiovascular diseases like ischemic heart disease, heart failure, and cardiac arrhythmia and arrest [5].

To take into account potential confounding environmental factors, we used meteorological data such as temperature and relative humidity. Data for 1-hour temperature (°C) and 1-hour relative humidity (%) were provided by 2 Meteo France stations located in Gironde. The arithmetic mean temperature and relative humidity were calculated to obtain daily mean values.

2.5. Statistical analysis

We used a time-stratified case crossover design coupled with conditional logistic regression as described by Maclure [11]. This method is widely used for analyzing short-term effects of air pollution on human health [12,13]. In the case-crossover design, the case is his or her own reference. A case corresponds to a day with a call for cardiac arrest. A time-stratified design was used to select control days, that is, the case was matched by the day in the week, and the associated control day was the same day in the week as the case day falling within the same period. Thus, for each case day, there were 3 control days because each period was composed of 28 days. For example, our first period was from January 1, 2007 to January 28, 2007; if a case occurred on Monday, January 8, then the 3 control days were the Mondays in the same period, that is, January 1, 15, and 22.

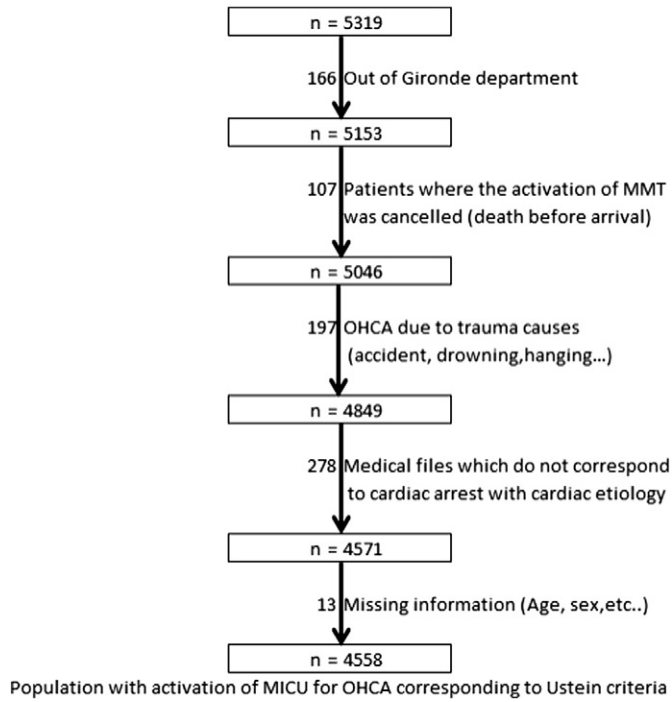

Fig. 1. Flow chart of the population excluded and remaining for the study.