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Session: D16 Air Pollution Exposure Symptoms, and Inflammation

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Air Pollution Associated With Acute Respiratory Distress Hospitalization of Elderly

ATS 2018, San Diego, CA – In a new study, researchers found significant associations between seniors' long-term exposure to two types of [air pollution](#) and hospitalization for [acute respiratory distress syndrome \(ARDS\)](#). The study was presented at the 2018 American Thoracic Society International Conference.

ARDS is a rapidly progressive disease that occurs in critically ill patients. The disease's most serious complication is that fluid leaks into the lungs making breathing difficult or impossible. ARDS develops in patients with predisposing conditions such as sepsis, pneumonia, traumatic injury, and aspiration. The elderly population is at particularly high risk of developing ARDS and the ARDS mortality rate for elderly patients has been reported to be around 69 percent to 80 percent.

“While there is growing evidence of the impact on lung health of numerous air pollutants, there have been few studies that have looked at acute respiratory diseases and air pollution across large populations,” said lead author Jongeun Rhee, ScD, of the T.H. Chan School of Public Health, Harvard University, Boston, Massachusetts.

Dr. Rhee and colleagues examined data from nearly 30 million Medicare beneficiaries (\geq age 65) per year discharged from American hospitals from 2000 through 2012. They tracked by zip code admissions due to an ARDS diagnosis. The researchers then computed annual average air concentrations of PM_{2.5},

pollution-causing particles that are about 30 times smaller than the width of a human hair, and annual average ozone concentrations for these zip codes from April through September. They developed statistical models that enabled them to make associations between air pollution levels and ARDS hospitalizations, and adjusted their calculations to compensate for differences in weather, race, socioeconomic status and smoking status.

Dr. Rhee's team found statistically significant associations between yearly change in PM_{2.5} and ozone concentrations and yearly change in hospital admission rates for ARDS among the nation's seniors. Hospital admissions for ARDS increased with increases in PM_{2.5} concentrations and increases associated with ozone levels as well. In low pollution regions, associations between chronic exposure to both PM_{2.5} and ozone had stronger associations compared to the entire U.S.

"We highlighted the importance of air pollution as an environmental risk factor for ARDS, which has not been studied widely but contributed to a previous finding that was limited to ozone," said Dr. Rhee. "Most importantly, we found increased hospital admission rates even when seniors were exposed to levels below current annual National Ambient Air Quality Standards (NAAQS) for PM_{2.5} (12 $\mu\text{g}/\text{m}^3$).

Dr. David Christiani, the study's senior author, stated that: "Our findings are unique in showing that the adverse health effects of air pollution on our senior citizens now include acute respiratory failure and that an increase in hospitalization for ARDS in seniors occurs at the current U.S. air pollution standards. These results add to the growing body of literature on various adverse health effects at current standards that demonstrate a need to lower our exposure limits."

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Revised Abstract

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Title: The Impact of Long-Term Exposure to PM_{2.5} and Ozone on the Risk of Acute Respiratory Distress Syndrome (ARDS) for the Elderly

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Rationale: The incidence of ARDS is reported to be from 64.2 to 78.9 cases/100,000 person-years in the United States. There is growing scientific evidence on the impact of short or long-term exposure to

various air pollutants on respiratory disease. However, there are few epidemiology studies investigating acute respiratory outcomes. Recently, Ware et al. found that chronic ozone exposure increased the odds of developing ARDS 1.6 times. In our study, we aimed to investigate the impact of exposure to PM_{2.5} and ozone on hospital admissions for ARDS using nationwide data.

Methods: The study population is from nearly 30 million Medicare enrollees (≥65 years old) per year from 2000 to 2012. We used hospital admissions data of Medicare beneficiaries and ARDS occurrences are defined by the ICD-9-CM discharge diagnosis codes. Our outcome of interest was annual counts of hospital admissions for ARDS at the zip code level. We computed annual average PM_{2.5} concentrations and annual average ozone concentrations during the warm season (April 1 through September 30) at each zip code, which were exposures of interest. We fit a two-pollutant generalized linear mixed model with a random intercept for zip-code assuming a Poisson distribution. Over-dispersion was allowed by using quasi-likelihood methods. Models were adjusted for sex, age, race, median household income, smoking and weather.

Results: In the Medicare cohort, there were a total of 1,164,784 hospital admissions for ARDS from 2000 to 2012. We included 37,167 zip codes for 13 years in our analyses. On average there were about three hospital admissions for ARDS within a zip code per year. Annual average PM_{2.5} and ozone concentrations were 11.0 $\mu\text{g}/\text{m}^3$ and 39.2 ppb, respectively. We found increases of 1 $\mu\text{g}/\text{m}^3$ in annual average PM_{2.5} and of 1 ppb in annual average ozone were associated with increases in annual hospital admission rates for ARDS of 1% (0.97%, 95% CI: 0.88, 1.07) and 0.13% (95% CI: 0.06, 0.20), respectively. In low pollution regions (annual average PM_{2.5} level less than 12 $\mu\text{g}/\text{m}^3$), the same annual increases in PM_{2.5} and ozone was associated with increases in annual hospital admission rates for ARDS of 1.71% (95% CI: 1.52, 1.91) and 0.30% (95% CI: 0.20, 0.39), respectively.

Conclusion: We found statistically significant associations between long-term exposure to PM_{2.5} and ozone concentrations and hospital admission rates of ARDS among more than 30 million Medicare beneficiaries from 2000 to 2012. In addition, we found increased hospital admission rates for ARDS even below current annual National Ambient Air Quality Standards for PM_{2.5} (12 $\mu\text{g}/\text{m}^3$).