CHEST

Original Research

PNEUMOTHORAX

Atmospheric Pressure Influences the Risk of Pneumothorax*

Beware of the Storm!

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Background: **Idiopathic spontaneous pneumothorax (ISP) results from rupture of blebs, bullas, or diseased alveolar walls. Initiating mechanisms may relate to increased transpulmonary pressure. The possible impact of changes in atmospheric pressure (Patm) on the occurrence of ISP remains uncertain.**

Methods: **We studied the relationship between the occurrence of ISP and meteorological conditions during a 4-year period in the urban area of Bologna, Italy, in which all cases of pneumothorax can be exhaustively identified. For each day of the study period, Patm and ambient temperature were obtained from the local meteorological institute. A *cluster* was defined as the admission of at least two patients with pneumothorax within 3 days of each other.**

Results: **There were 294 episodes of ISP; 247 (84%) occurred in 76 clusters. Clusters were significantly associated with wider differences in Patm between the index day (*ie*, the first day of the cluster) and the previous day (*ie*, the difference in mean [± SEM] Patm, −1.23 ± 0.45 vs + 0.04 ± 0.12 mm Hg, respectively; p = 0.01[analysis of variance]). Similarly, pneumothorax and storms (but not temperature) were significantly associated ($p < 0.0001$ [χ^2 test]).**

Conclusions: **This large-scale study shows that patients with ISP are hospitalized in clusters and suggests that important variations in Patm may be involved. The knowledge of this relationship may help to understand the pathophysiology of the disease.**

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Key words: pneumothorax; pressure; storms; temperature

Abbreviations: ISP = idiopathic spontaneous pneumothorax; Patm = atmospheric pressure; Patmmax = maximal atmospheric pressure; Patmmean = mean atmospheric pressure; Patmmin = minimal atmospheric pressure; Tatmmean = mean atmospheric temperature

Idiopathic spontaneous pneumothorax (ISP) is defined as a pneumothorax occurring in patients with no underlying pulmonary disease. On the basis of a CT scan, and thoracoscopy and thoracotomy findings, ISP is generally thought to result from the rupture of blebs or bullas.[1] It has been suggested that the rupture of the alveolar walls in diseased portions of the lung that is characterized by the porosity of visceral pleura may represent another pathogenic mechanism.[2] The factors responsible for the initiation of air leaks are not known, but it is

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believed that rupture may occur when a substantial transpulmonary pressure gradient is present.[3] In these circumstances, the pressure equilibrium between surrounding structures and air trapped in blebs, bullas, or diseased alveoli fails to be reached rapidly, resulting in rupture.[3] Conditions associated with the check-valve phenomenon (*ie*, mucus retention or bronchiolitis) are known to predispose a patient to pneumothorax.[1] Exposure to rapid changes of environmental pressure (*eg*, scuba diving[4] or flying[5]) may also result in pneumothorax in healthy individuals.

The possible impact of changes in atmospheric pressure (Patm) on the occurrence of ISP has been investigated in some studies,[3,6–9] but the results are largely controversial. In the present study, we aimed at evaluating the relationship between the occurrence of ISP and climatic conditions. Such an association would help the understanding of the pathophysiologic mechanisms involved in the occurrence of ISP.

Materials and Methods

Study Design and Population

In the urban area of Bologna (350,000 inhabitants), Italy, all cases of pneumothorax are systematically referred to the emergency units of two hospitals. We identified the records of patients with ISP from the electronic database of all patients who had been hospitalized in the two city hospitals between January 1, 2000, and December 31, 2003. Participating hospitals do not receive referrals from institutions located outside the area of the study.

Pneumothorax was always diagnosed on the basis of chest radiograph findings. All cases of ISP were included in the study, regardless of their size. As previously reported, a *cluster* of pneumothorax cases was defined as the admission to the hospital of at least two patients with pneumothorax within 3 days of each other.[10,11]

Meteorological Data

For each of the 1,461 days of the study period, meteorological data were obtained from the local meteorological institute, which is located at the same altitude as the participating hospitals, within a 12-km-wide area. The maximal Patm (Patmmax), the mean Patm (Patmmean), and the minimal Patm (Patmmin), and the maximal atmospheric temperature, the mean atmospheric temperature (Tatmmean), and the minimal atmospheric temperature at ground level were extracted for each study day. Differences in the Patmmean and the Tatmmean between each day and the previous one (D − 1) were calculated, as well as the wider temperature and pressure variations (maximum values of the considered day − minimum values of the previous one, and *vice versa*). Similar calculations were made to assess differences in atmospheric temperature and pressure between D − 1 and D − 2 and between D − 2 and D − 3 of each study day. Information about storms (*ie*, the presence or absence for each study day) was also obtained. A storm was qualitatively defined as a heavy rainfall along with thunder and lightening (thunderstorm).

Statistical Analysis

Quantitative data were described as the mean ± SD. The relationship between the occurrence of (1) pneumothorax (*ie*, days with pneumothorax) and (2) clusters (*ie*, the first day of the cluster) on the one hand, and (1) storms, (2) variations in Patm, and (3) variations in temperature, on the other hand, were analyzed with the χ^2 test for categoric variables and Student *t* test for quantitative variables with Bonferroni-Dunn correction for multiple comparisons. A p value of ≤ 0.05 was considered to be significant. A statistical software package (Statview, version 5.0; SAS Institute; Cary, NC) was used for statistical analysis.

Results

There were 294 episodes of ISP, which occurred in 271 days. Two hundred forty-seven of 294 episodes (84%) of pneumothorax occurred in 76 clusters (Fig 1, *top*, *A*). The mean number of pneumothorax episodes per cluster was 3.2 ± 1.8. Figures 1, *middle*, *B*, and *bottom*, *C*, illustrate trends in the Patmmean and Tatmmean throughout the duration of the study. All values (maximum, mean, and minimum) of temperature and pressure were available for 1,214 study days (83.1%) and 1,461 study days (99.9%), respectively. Storms were recorded on 48 days.

Relationship Between Pneumothorax and Meteorological Conditions

As shown in Figure 1, no seasonal predominance of clusters could be identified. No relationship was found between days with pneumothorax or clusters and variations in atmospheric temperature (data not shown). Similarly, the numbers of pneumothorax in clusters did not correlate with Patm and temperature (data not shown).

Conversely, clusters were significantly associated with wider differences in Patmmean between the index day and the previous day, and between the Patmmin and the Patmmax on the previous day (Table 1, Fig 2). More specifically, clusters occurred during or immediately following wide drops in Patm. Finally, a significant association was found between days with pneumothorax and days on which storms occurred (Table 2).

Discussion

This large-scale study confirms that microepidemics of ISP occur, and that episodes of pneumothorax are associated with drops in Patm and storms. Smit and colleagues[3,10] reported that 73% of ISP were admitted in clusters. Based on their clinical impression, they defined the occurrence of a cluster as when two or more patients with pneumothorax were admitted to the hospital within 3 days of each other.