

Original Article

Do Weather Phenomena Have Any Influence on the Occurrence of Spontaneous Pneumothorax?☆



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ABSTRACT

Introduction: The objective of this study was to assess the impact of weather phenomena on the occurrence of spontaneous pneumothorax (SP) in the Plzeň region (Czech Republic).

Methods: A retrospective analysis of 450 cases of SP in 394 patients between 1991 and 2013. We observed changes in average daily values of atmospheric pressure, air temperature and daily maximum wind gust for each day of that period and their effect on the development of SP.

Results: The risk of developing SP is 1.41 times higher ($P=.0017$) with air pressure changes of more than ± 6.1 hPa. When the absolute value of the air temperature changes by more than $\pm 0.9^\circ\text{C}$, the risk of developing SP is 1.55 times higher ($P=.0002$). When the wind speed difference over the 5 days prior to onset of SP is less than 13 m/s, then the risk of SP is 2.16 times higher ($P=.0004$). If the pressure difference is greater than ± 6.1 hPa and the temperature difference is greater than $\pm 0.9^\circ\text{C}$ or the wind speed difference during the 5 days prior to onset of SP is less than 10.7 m/s, the risk of SP is 2.04 times higher ($P\leq.0001$).

Conclusion: Changes in atmospheric pressure, air temperature and wind speed are undoubtedly involved in the development of SP, but do not seem to be the only factors causing rupture of blebs or emphysematous bullae.

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¿Tienen los fenómenos meteorológicos alguna influencia en la aparición de neumotórax espontáneo?

RESUMEN

Introducción: El objetivo de este estudio fue evaluar la influencia de los fenómenos meteorológicos en la aparición de neumotórax espontáneo (NE) en la región de Pilsen (República Checa).

Métodos: Análisis retrospectivo de 450 casos de NE en 394 pacientes durante los años 1991–2013. Se analizaron los valores diarios medios de presión atmosférica, temperatura ambiental y la velocidad máxima diaria del viento y sus cambios cada día en ese período, en relación con la aparición de NE.

Resultados: El riesgo de desarrollar NE aumentó 1,41 veces ($P=0,0017$) en el caso de cambios mayores de $\pm 6,1$ hPa en la presión atmosférica. Cuando el valor absoluto de los cambios de temperatura ambiental era mayor de $\pm 0,9^\circ\text{C}$, el riesgo de aparición de NE aumentó 1,55 veces ($P=0,0002$). Cuando la diferencia en los cambios en la velocidad del viento en los 5 días previos al inicio de NE era menor de 13 m/s, el riesgo de NE aumentaba 2,16 veces ($P=0,0004$). Si la diferencia de presión era mayor de $\pm 6,1$ hPa y la diferencia de temperatura mayor de $\pm 0,9^\circ\text{C}$ o la diferencia en la velocidad del viento en los 5 días previos al inicio de NE era inferior a 10,7 m/s, el riesgo de NE aumentaba 2,04 veces ($P\leq 0,0001$).

Palabras clave:

Neumotórax espontáneo

Presión atmosférica

Temperatura ambiental

Velocidad del viento

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Conclusión: Los cambios en la presión atmosférica, la temperatura ambiental y la velocidad del viento están indudablemente involucrados en la aparición de NE. Sin embargo, no parecen ser los únicos factores causantes de la rotura de las vesículas o las ampollas enfisematosas.

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Introduction

Spontaneous pneumothorax (SP) develops as a result of the rupture of subpleural blebs, emphysematous bullae or other damage to the pleura or alveolar walls. The rupture may be caused, among other things, by an increase in transpulmonary pressure.^{1–5} Since cases of SP often occur in groups within a short timescale, some authors suggest that they can develop as a result of weather phenomena that cause changes in transpulmonary pressure. These theories have been discussed repeatedly in the literature, but the findings are inconsistent.^{1,2,6–12} The aim of this study was to evaluate the possible influence of certain weather phenomena (changes in air pressure and temperature, wind speed, storms) on the emergence of SP among patients in the Plzeň Region (Czech Republic).

Materials and Methods

This is a retrospective analysis of 450 cases of spontaneous pneumothorax in 394 patients treated between 1991 and 2013 at the Surgery Department of the University Hospital in Plzeň. The patient population consisted of 318 men and 76 women with the mean age of 42 years; the youngest patient was 13 years old, while the oldest was 90 years old. Two hundred and eight (208) patients had so-called primary pneumothorax (52.8%), and 186 patients had secondary pneumothorax (47.2%). The population of the Plzeň region is over 573,000 inhabitants. Meteorological data for the region were obtained from the Plzeň office of the Czech Hydrometeorological Institute. The average sea-level pressure for the Plzeň area is 1013 hPa, and the average daily pressure variation is 4 hPa. The long-term average air temperature in this region is 8 °C, while the average daily temperature deviation is 1.9 °C. We observed changes in average daily values of atmospheric pressure in hPa, the average daily air temperature in degrees Celsius, the maximum daily wind gust in m/s, and occurrence of storms for each day of that period and their potential effect on the development of SP compared to the previous period.

Development of SP was described using clusters, where a cluster was defined as at least 2 cases of SP over 3 days. When such clusters were detected, we analyzed the first day of the cluster or the values of parameters over the previous 5 days. In addition to the defined clusters, we found an isolated SP rarely, where the decisive day was the day of SP development, or values of parameters investigated over the maximum of the previous 5 days. We examined the values of the parameters on the day of SP development compared to the previous day. We also examined the differences and quotients of the parameters between the onset date of SP (cluster) and the previous day, the differences and quotients of the values over the 5 days prior to development of SP, and the absolute value of these differences and quotients. Onset of SP was indicated as the first day of symptoms.

Statistical analysis was performed using SAS (SAS Institute Inc., Cary, NC, USA). Basic statistical data were calculated for the parameters measured in the entire population and in the respective groups. Distribution of the individual parameters in different groups and subgroups was compared using a Wilcoxon two-sample test. Cut-off values of changes in the study parameters were identified using ROC curves and maximizing the Chi-square test criterion. Multivariate analysis of the impact of various factors on the development of SP was performed using logistic regression. The individual

factors, and various combinations of cut-off values of the examined factors were combined using “OR” and “AND” statistics (criteria for presumed development of SP). The risk of SP development at different values of the examined variables, and “OR” and “AND” combinations, were expressed using the Odds Ratio (plus 95% confidence interval). Statistical significance was set at $\alpha=5\%$.

Results

Men were significantly more affected than women in the study population, while the elderly were more affected in the female cohort. Development of SP occurred in 450 (5.35%) of the total of 8401 monitored days. A total of 54 clusters were identified, which resulted in 105 cases of SP (23.3%). Outside the clusters, we recorded 345 cases of SP (76.7%).

In cases of SP, statistically significant increases in the absolute values of changes in air pressure were recorded between the date of onset of SP and the day preceding the day of SP occurrence (Wilcoxon test: P -value=.0360). Using multivariate analysis (logistic regression), this factor was designated as the only statistically significant air pressure factor influencing development of SP. Air pressure changes of more than ± 6.1 hPa increased risk for SP by 1.41 times (Chi-square test: P -value=.0017; 95% confidence interval of the risk: 1.14–1.76) (statistically the strongest cut-off).

Similar statistically significant differences were found in air temperature on the day of occurrence of SP compared to the days without SP (Wilcoxon test: P -value=.0002). When the absolute value of the air temperature changed by more than ± 0.9 °C, the risk of SP was 1.55 times higher (Chi-square test: P -value=.0002; 95% confidence interval of risk: 1.23–1.94) (statistically the strongest cut-off).

We found statistically significant differences in wind speed on the day of development of SP, where the wind speed was higher in the SP group (Wilcoxon test: P -value=.0163). However, some of the wind speed changes were less clear. After further statistical analysis, we concluded that the difference between the minimum and maximum value of the wind speed over the 5 days prior to development of SP was significantly lower in the SP group (Wilcoxon test: P -value=.0438). Multivariate analysis (logistic regression) identified the difference between the minimum and maximum wind speed as the most statistically significant factor. When the wind speed differed by less than 13 m/s over the 5 days prior to onset of SP, the risk of SP was 2.16 times higher (Chi-square test: P -value=.0004; 95% confidence interval of the risk: 1.40–3.34) (statistically the strongest cut-off). (Fig. 1).

We also examined different combinations of the factors studied (wind temperature, pressure, speed) and their possible cut-offs at the development of SP. If the difference between temperatures was greater than ± 0.9 °C or that of wind speed over the 5 days prior to onset of SP less than 13 m/s (the “OR” combination), the risk of SP was 3.24 times higher (Chi-square test: P -value=.0143; 95% confidence interval of the risk: 1.20–8.74). This condition was met in 99.11% of all SP studied. Other variants of the “OR” combinations have not yielded similarly good results. When the pressure difference was greater than ± 6.1 hPa and the temperature difference greater than ± 0.9 °C or the difference in wind speed over the 5 days prior to onset of SP was less than 10.7 m/s (“AND” combination), the risk of SP was 2.04 times higher (Chi-square test: P value=<.0001;

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